The Pioneer Electrical Journal of America.

PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY, Limited.

41 PARK ROW (TIMES BUILDING), NEW YORK.

Established 1874. Incorporated 1889.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 620 Atlantic Ave., Boston.
Western Office, 936 Monadnock Block, Chicago.
Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.

(Including Postage in the U. S., Canada or Mexico.)

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41 Park Row, New York,

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VOL. XXII. NEW YORK, NOV. 18, 1893. NO. 21.

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The Edison Lamp Case. THE United States Circuit Court of Appeals on Monday, Nov. 13, handed down a decision which reverses in a great measure the decision of Judge Lacombe enjoining two electric light companies in New York from using Edison lamps. The new decision is to the effect that the Edison company is bound to furnish lamps on reasonable terms for plants installed prior to July 14, 1891, the date of the decision sustaining the Edison lamp patent.

Electricity on Canals. IT is expected that the first trial of electrical propulsion on the Erie Canal will take place during the present week. It seems that a canal boat has been fitted with a propeller which will be driven by an electric motor supplied by current from a trolley line along the banks. As far as the actual propelling of the boat is concerned this does not differ from steam propulsion, and we cannot see in what way the objections against the latter system are obviated by the proposed one. We understand that of the numerous schemes proposed for canal propulsion, in competition for the prize of $100,000 offered by the State some years ago, it was decided that none would be considered which involved a disturbance of the water that would injure the banks, and as a consequence all plans involving the use of propelling wheels and screws were ruled out. Any method of propulsion based upon the reaction of water involves a current in a direction opposite to that of the vessel, as the resistance of the vessel into its speed is balanced by the momentum of the column of water astern. One result of the trial may be to show that the current thus set up does not have the injurious washing effect on the banks ascribed to it, and thus leave the question of electrical propulsion one for merely commercial calculation, as there are no engineering difficulties beyond the construction of the trolley line.

High Frequency Currents. IN another column Lieut. Patten shows how high frequency currents may be practically generated by a series of similar alternators with their armatures on the same shaft, and the field of each excited by the current from the armature next before it in the series. As pointed out, however, the E. M. F., if the alternators are identical, is decreased in the same ratio as the frequencies are increased, which limits this disposition for practical purposes. It nevertheless has a value for experimental purposes where it is desirable to know the exact frequency, and it is probable that by a proper proportioning of the different armatures and fields the falling off referred to may be largely reduced. It should be borne in mind that, aside from the usual losses in the different fields, armatures and condensers, there is no loss of energy due to the successive decreases in output. This decrease follows from the character of the field generated by the alternating field current, which reduces the output of the armature, but yet only expends energy in proportion to the reduced capacity. As remarked by Lieut. Patten, the method is suggestive in several ways, and the ingenious manner in which he arranged the laboratory apparatus, described in former articles in the series of Laboratory Notes, to test the truth of the theoretical deduction, shows that the most complicated questions can be treated experimentally with simple and inexpensive apparatus.

Lighting of Workshops. THE Digest refers to the use of inverted arc lamps for lighting workshops, which is a subject worthy of more attention than it has received in this country. This method has, we understand, been considerably employed on the Continent, and it is undoubtedly greatly preferable to the ordinary use of the arc lamp, and has advantages even over incandescent lighting, besides being much cheaper. There is an entire absence of glare, and, as pointed out, the light reflected from the white surfaces is so diffused as to cast no shadows. While the glare of incandescent lamps is of course less objectionable than that of arcs, the necessity of having them near to persons working overbalances this advantage in many cases. As to the relative cost of arc and incandescent lamps, experiments at the Antwerp electrical exhibition showed that a 10-ampere 45.5-volt arc, having a maximum candle power of 2,070, gave forth a mean spherical candle power of 750, of which 640 was below a horizontal plane passing through the arc. As the entire spherical candle power would be utilized by the method referred to, this would be equivalent to 46.9 sixteen candle power incandescent lamps, which, at 60 watts per lamp, would require 2,814 watts as against 455 with an equivalent arc lamp. This would be an apparent saving of about 500 per cent., which would, however, be somewhat reduced by all the space being almost uniformly lighted by the arc. The saving would nevertheless be very considerable, and the more evenly distributed and whiter light with the absence of the glare of the incandescent filaments would be additional advantages.

Size and Output of Dynamos. IN this issue we print the first section of an article on the relation between the increase of the dimensions and rise of output of dynamos, which considers the subject in a thorough manner, and the conclusions are shown to be in accordance with the best practice. This is a subject that has been much discussed and with a great divergence of views, caused by the different assumptions upon which they have been based. The exponent of the ratio of the linear dimensions of the machines to be compared, with respect to output, has had a value as high as 5 assigned to it (S. P. Thompson) and one as low as 2 (Mascart and Joubert). Between these limits, among others, are the values of 3 (Hopkinson), 4 (Frölich), and, more recently, Kapp has placed it at 3.5 and Ayrton at 3.7. Mr. Wiener, in his article, shows that the value of the exponent varies with the voltage and with the ratio of the two machines compared, becoming smaller as the ratio becomes larger. As will be seen, the minimum value of the exponent deduced is 2.5, corresponding to a ratio of lineal dimensions greater than 8 and a voltage ratio of over 10, and the maximum value, 3, corresponds to ratios less than 2 and one-sixth respectively. These results are considerably less than those of Kapp and Ayrton, which are probably also based upon a careful study of the commercial factors involved, and a comparison of the several methods pursued would be not only interesting, but might result in arriving at a closer agreement on a constant of considerable value in preliminary dynamo design. In any case, however, we doubt if the complete design of a dynamo would be based upon this method of comparison, as it assumes perfection in the machine taken as a standard, and disregards the different rates of variation with the size and object of the machine, of some of the factors.

The English Edison Lamp Patent. THE English Edison lamp patent expired on Nov. 10, 14 years from the date of application. Although this date is previous to that of the American patent, the lower United States courts have decided that the date which shall prevail with reference to the statute limiting the life of an American patent by that of a foreign one previously granted is, in the case of an English patent, the date of filing the final specifications (Feb. 6, 1880) or when the great seal is attached (May 10, 1880). While the decisions thus conflict as to the date to apply, the preponderance of opinion being in favor of the latter, both dates are subsequent to that of the American patent, Jan. 27, 1880. The life of the American patent is therefore not affected by that of the English one according to the lower United States courts, and there does not seem to be the slightest probability of the United States Supreme Court reversing the point of law thus established. There is still another point connected with the English lamp patent, based upon an indorsement on the American patent, made by the Commissioner of Patents at the request of the Edison attorneys, limiting its life to that of the foreign one having the shortest life. Among the patents enumerated in the indorsement is the English one, to which the date of Nov. 10, 1879, is assigned. In subsequent lamp litigation this point was brought forward, but the court decided that the indorsement was void on account of the Commissioner of Patents having no authority to make an indorsement on a patent after it was granted, and that besides the courts would determine for themselves the questions and dates relating to the application of the statute of limitations. While neither of the above points has been passed upon by the U. S. Supreme Court, there does not seem to be any reason to think that it would take a view differing from that of the lower courts. There is little question, however, but that the patent will expire with the Canadian one on Nov. 19, 1894, the legal point bearing on this date being not less firmly established than those just referred to.

Municipal Lighting Plants. THAT the sentiment in favor of municipal electric plants is growing is shown by the increasing number of such plants reported in our news columns. As yet they are confined to the smaller towns, but the experiment will soon be tried in two large cities in the West. It is too soon as yet to draw any conclusion as to the wisdom of municipal governing bodies thus entering the field in question, and it is not probable that the final results will justify either a definitely favorable or unfavorable judgement. Everything depends upon whether politicians will be able to control matters or whether the electric lighting department will be conducted on business principles. In the former case failure is inevitable, and it is folly for any town or city to propose to run its own electric lighting plant if it cannot be kept free from this influence. In our news columns reference is made to three town plants, of which two seem to be satisfactory, while the third, which we learn is run by an alderman's son, is said to be in a fair way of soon becoming a scrap heap. In another instance we know of, a town plant which when managed by a council committee composed of typical politicians was a disgrace, but gave satisfactory results when placed in the hands of a commission which conducted it on business principles. In still another instance a small town purchased a plant for both public and commercial lighting, but owing to the small number of lights used, its charges were relatively high, and therefore the venture is considered a failure, although it might not have been otherwise were it a private enterprise. There are many towns in which it would not pay private capital to install a plant, but this consideration is very apt to be lost sight of in the agitation for one at the public expense; besides, even under the best possible circumstances it is not probable that the same economy will be exercised in the conduct of a public charge. As a consequence it follows that any idea that in a small town the electric light can, as a matter of course, be had at a low figure by investing the public money is likely to prove delusive, however honest the administration may be.

Candle Power of Search Lights.

In connection with the discussion about the candle power of search lights, which has been going on in our columns (see The Electrical World, Oct. 21, p. 318; Oct. 28, p. 332, and Nov. 4, p. 356), the following editorial from the London "Electrician" is of interest. It refers to a letter of Mr. Steinmetz, which was similar to the one which he sent us:

"Mr. Steinmetz writes to us this week to defend the high estimates of the candle power of search lights which have from time to time been made. We cannot agree with him. There are two ways of measuring candle power. The ordinary way is direct and assumes that the rays of light are emitted from a point. Having adjusted a photometer at a certain distance from this point, the candle power is directly as the square of this distance. The other way is not so common, but it must sometimes be used. The illumination of a surface upon which the light falls is measured, and the candle power is calculated as that which would give the same illumination if emitted from a point at a certain distance. We have already pointed out in connection with a lighthouse at a London exhibition that, as measured photometrically, if the beam is strictly parallel the candle power would be indefinitely great, and if the beam were slightly converging the candle power would be more than infinite; in fact, the word candle power ceases then to have any meaning.

"But Mr. Steinmetz sins in good company. Dr. J. Hopkinson, at the South Foreland lighthouses, in 1884 and 1885, made measurements which purported to give the candle power of the lights. With due deference to such an authority we venture to suggest that what he did do, and what Mr. Steinmetz has done, is to make a photometric measurement and to take the square of the distance from the light as if it were a radiant point. In practice, the beam of a search light is never truly parallel. It consists of a number of nearly parallel rays mixed with diverging and with converging rays. The latter cross the axis, and at a considerable distance the rays may be all considered as diverging. In certain cases a diverging beam is intentionally used. The light then proceeds as if from a point at a considerable distance behind the projector. The value of a search light may be estimated in terms of the quantity of light sent in a given direction in a nearly parallel beam, and not by its candle power, which is a very different thing. The two concluding sentences of Mr. Steinmetz's letter need the following qualification. The rays from the arc would proceed practically as from a point, diverging from it; the illumination produced by it would be inversely as the square of the distance from this point. But there is little or no such divergence with the search light, and therefore the candle powers cannot be compared."

American Institute of Electrical Engineers.

In a communication received from Mr. W. J. Hammer, reference as follows is made to the report in our columns on the recent monthly meeting of the American Institute of Electrical Engineers: "In a note in your article on the monthly meeting of the American Institute of Electrical Engineers, page 330 of The Electrical World, Oct. 28, you said that 'the omission of the two gentlemen who read papers on the subject was doubtless an oversight due to the haste in naming the committee as the meeting was breaking up.' Whoever reported the proceedings failed to note that the motion was that the gentlemen composing this committee should be members of the council. This was also stated from the chair, and for that reason the two names were omitted. I might call your attention to the fact that I was appointed on this committee, but my name was not mentioned with those of Webb, Phelps, Pupin and Kennelly."

We were under the impression at the time that the committee referred to was to consist of five members, but after diligent inquiry we could only learn the names of the four gentlemen mentioned in our report, and as a consequence the name of Mr. Hammer did not appear, which omission we regret.

The correction in regard to the committee appointed to consider the question of local meetings does not explain why its membership should have been confined to members of the council alone, a point of some importance in view of the recent assumption of one of the members of the committee that the council is a supreme body whose decrees cannot be questioned by the Institute. Such an explanation would also be interesting in connection with the report that the council a few hours previously considered unfavorably the request of Chicago members to be allowed to hold a local meeting. Moreover, one of the gentlemen who read a paper on the subject of local meetings (which, by the way, proposed a liberal programme) is, we find, a member of the council, and yet was not appointed on the committee; this, however, we feel, was undoubtedly due to an oversight on the part of the chairman, whose appointments on the committee assures a majority, in which we include Mr. Hammer, that will consider the important question placed in their charge in no narrow or factional light.

Laboratory Notes.—X.

BY LIEUT. F. JARVIS PATTEN.

HIGH FREQUENCY CURRENTS BY MECHANICAL MEANS.

How to obtain alternating currents of high frequency by mechanical means was briefly considered under the subject of the motor-dynamo. The plan for accomplishing this that will now be indicated would have been out of place in that connection, not only because the machine used is not strictly a motor-dynamo, but the method itself is novel and deserves separate treatment. I am not yet able to state from actual experiment how far this method is feasible, but I have applied it to a limited extent and the plan works in accordance with the indications of analysis. The method is suggestive in many ways and presents many problems of interest to the engineer.

The system depends for its operation upon a principle recently demonstrated in these columns by Mr. W. D. Weaver, which shows that if two similar alternating current dynamos have their armatures secured to a common spindle, and the current from one armature, designated as the first, be used as an exciting current for the field of the second, the first having its field excited by direct current in the usual way, then the current delivered by the second machine or armature will have a frequency double that of the first.

Without going into the why and wherefore of this, but assuming the principle as stated, it gives a means, more or less limited by the conditions of the problem, of changing the frequency of a given alternating current.

Two possible applications at once suggest themselves. First, given an alternating current generated, say, by a 16-pole machine driven at 1,000 revolutions a minute, and given a synchronous motor driven by this alternating current at 1,000 revolutions a minute at the point where it is desired to have a current of double the frequency of the given current, it is only necessary to cause the synchronous motor to drive a similar alternator, i. e., having the same number of poles and field coils as the generating dynamo, and excite the fields of this machine by the given alternating current, then the current delivered by its armature will have a frequency just double that of the alternating current supplied from the distant station, a certain and reliable means of obtaining a current having double the frequency of a given current.

The second application, it will be seen, may be used as an extension of the first. Take the original case cited for illustration, that of two similar alternators having their armatures carried by the same spindle, the current from the first exciting the field of the second. Now let the current from the second armature excite the field of a third machine, and that from the third armature excite the field of a fourth, and so on. Arranged thus, the second armature yields a current of double the frequency of the first, the third gives a current of double the frequency of the second, and the fourth armature doubles the frequency again, and so we may go on doubling the frequency with each successive machine, until, as we shall find, certain conditions introduced by this process of mechanical multiplication will place a limit to its indefinite extension. These conditions will be briefly considered later, but whatever they are, and however rapidly energy may be dissipated by such a system, the oscillations will still remain and may have their effect upon the molecular constitution of matter long after such manifestations of energy as are perceptible to the senses have disappeared.

Such a contrivance as I have described for multiplying frequency I will designate for sake of a name "the multi-frequency generator," the general plan of which is shown by diagram in Fig. 13, where D_1, D_2, D_3, represent three successive alternators having a common spindle p p. The field of the first machine D_1 is excited in the usual way by a direct current as indicated by the battery at B.

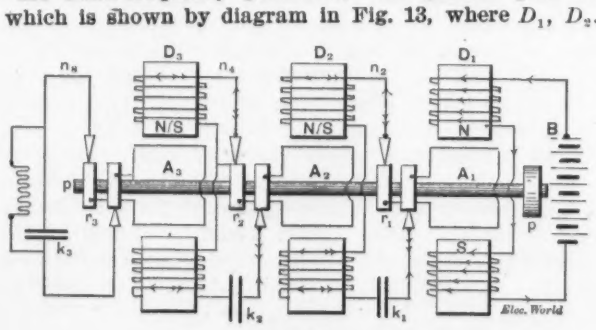


Fig. 13.

The circuit of the armature A_1 is taken to the field of the second machine, and so on through the series to the last armature circuit, which is the working circuit at the frequency desired. Plainly, in such a system the frequencies from one machine to the next go on doubling as the series 2, 4, 8, 16, etc. Thus, if the first machine had 12 poles and made 40 revolutions a second it would give 480 reversals a second while the third would give four times this frequency, or 1,920 a second.

This certainly looks like a very easy system of mechanical multiplication, and before considering the limiting conditions let us see what frequency a number of such machines could give.

Evidently something is gained by starting with a many pole machine, say 24, and many revolutions per second, say 50—a practical speed for such machines as would be constructed for experiments of this sort. That means 1,200 reversals a second at the first machine—for the initial frequency—nearly 10,000 a second at the fourth, about 20,000 at the fifth, and the eleventh armature in the series would give more than a million and a quarter reversals a second of absolute uniform frequency.

What the possible limit to this application is depends upon a variety of conditions which all tend to the dissipation of energy and the gradual reduction of the current to zero, which we shall see approaches the limit as the frequency increases.

Let these conditions be considered for a moment with a view to determine whether or not a current of very high frequency can be obtained by this method.

After the initial field circuit every other circuit has an alternating current, thus self-induction will everywhere play an important part; but fortunately the self-induction only increases as the frequency directly, and not as the square or higher power. The self-induction will cause the current to lag behind its electromotive force, and if allowed to increase sufficiently it will finally prevent the flow of current in a circuit, and there will be no field excitation for the next armature. A condenser in a circuit having self-induction has an opposite effect, tending to urge the current forward into phase with its E. M. F., and, given the self-induction of a circuit, the required capacity of a condenser suited to balance or offset the effect of self-induction can be calculated for a given frequency. The condensers indicated in Fig. 13 at k k will therefore vary from point to point in capacity.

Far more important, however, than the increasing self-induction of these circuits, is another factor that reduces the current as we pass from one armature circuit to the next. This factor only becomes evident upon examination of the analysis given in the article cited.

The E. M. F. of the first machine, as in an ordinary case, is a function of sin. , the angle of advance of the first armature coil from the zero position—and the E. M. F. of the second armature (revolving in an alternating field) is a function of sin. Θ cos. $\Theta = \frac{1}{2}$ sin. 2Θ from which it is evident there must be four maxima and four zero periods in each complete revolution as compared with two in the other, or the second current has double the frequency of the first. If, however, we inquire what the maximum value of sin. Θ cos. Θ, the E. M. F. of the second armature is, we find that it is only one-half, as compared with unity, the maximum value of the E. M. F. of the first armature. It therefore appears that, while the frequency of the current has been doubled, the E. M. F. has, at the same time, been halved, so that from the second armature we will get only half the E. M. F. we started with. It will be halved again at the next armature, and for every increase in the frequency we find a corresponding diminution of the resulting E. M. F. and current, which looks very much like the transforming E. M. F. into frequency.

Fig. 14 shows the curves for four successive alternating currents, and from this it is apparent that if we wish, by many repeated transformations, to attain a very high frequency, we shall be compelled to start with a very high electromotive force. Thus neglecting other losses for the present, and supposing ten successive armatures were used, with 10,000 volts at the first machine, and a frequency of 1,200 per second, we should have at the tenth armature circuit only 18 volts and 614,400 reversals a second. In fact the other losses not here considered would probably reduce the voltage to this amount at the fifth armature. The assumption of so high a starting voltage, however, is not so inconsistent as might at first appear, when we consider that the high tension circuit need have no break whatever, the armature circuit, high tension alternating, being closed on itself through the primary of a transformer carried on the same spindle, its secondary being taken to the next field or exciting circuit, and so on.

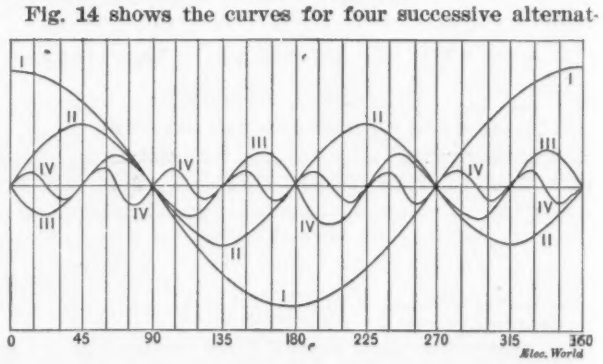


Fig. 14.

The effects of self-induction being greatly increased by the presence of iron in every circuit of such an apparatus, it will be desirable to use as little iron as possible. A plan of construction which I have tried has both field and armature combined in one structure, and that in the form of a finely laminated ring. Each successive dyna-

namo, i. e., field and armature, consisting of a finely divided ring, provided with a double winding—one of coarse wire to take the low tension exciting (field) current through as many brushes bearing on a large collector outside the ring as it is desired to give poles to the ring. The other circuit (intermediate coils) corresponding to the armature is fine wound and connected in series. If we suppose 480 coils in all, 240 would constitute the field winding to which exciting current would be introduced through 24 equidistant brushes having 10 coils between each successive pair, and on this plan the excitation could be effected, as desired, by 24, 12 or 6 parallel circuits.

If the other circuit (armature) be connected in series for voltage it will be necessary to reduce it before using it as an exciting or field current for the next ring, as it would not be practical to use such a current with many brushes and a collector. As it will not be desirable to have the high tension circuit open, except for use external to the machine, the reducing transformer must also be carried on the spindle between the rings. The secondary or low tension circuit of this transformer is then taken to the 24 brushes of the exciting circuit of the next ring, and so on, through the series.

It might well be asked, Why generate a high tension current and then reduce to low tension for use in the next machine? The answer is that the machine described is intended as one from which any frequency within its limits may be had by selecting one armature circuit or another as the working circuit or circuit for experiment, and as these currents are generally required at a high voltage it is suggested that they be originally generated at high tension in each machine ring.

An interesting question is, To what extent, if any, is such an apparatus reversible, and what will the results be? I am not yet prepared to answer this question from the standpoint of practical experiment. That the frequency doubles and the voltage falls correspondingly by going one way seems proved by the tests I have made. If the machine, Fig. 13, is driven synchronously and alternating current of a given frequency is introduced to the armature circuit, A_1, will there be a current of half this frequency in the circuit of A_2, and one of quarter the frequency in the field circuit of A_1? If so, the device presents a means of obtaining a low frequency current from the ordinary lighting circuits.

A description of the apparatus first used to make the increased frequency experiments at my laboratory serves to show how easily some apparently complex experiments can be carried out.

A motor-dynamo (Brush machine altered) like that shown in Fig. 10 was taken for the initial alternate current generator being driven as a motor by direct current, thereby generating a single alternating current in its second armature winding.

Geared to this machine so as to go at the same speed was a spindle carrying a double wound Gramme ring. One circuit of the Gramme was connected to a collector in the ordinary way as shown in Fig. 2 (fourth paper) and the other winding had two diametrically opposite points connected to two rings as there indicated.

This arrangement dispenses with the field poles of Fig. 2, and makes a dynamo out of a single ring as before suggested, the poles being established in the ring itself on a line joining the two brushes that bear on the collector through which current is introduced to one winding that acts as a field winding and answers all the purposes of two separate field poles.

Only two brushes are used, making but one polar line, as the Brush machine, the first alternator, is a two-pole machine. But an alternating current taken from the armature of the motor-dynamo is taken to the brushes of the driven Gramme ring, so that its field, instead of being a constant one, as would be the case if produced by a direct current so introduced, is an alternating or reversed one, the rate of reversal being determined by the armature current of the first alternator. The secondary or armature winding of this ring is then revolving through an alternating field created by the current of the first machine while both are moving at the same speed, and the alternating current from this ring should then have double the frequency of that delivered to it by the motor-dynamo.

In other words the Gramme ring so driven becomes in fact a rotary transformer that doubles the frequency of a given current. To determine this fact by experimental proof, shunts were connected around the armature circuits of the two machines and a polar relay connected in each shunt was arranged to actuate each an independent telegraph sounder, which were placed side by side on the same table, and incandescent lamps were also connected in series in the sounder circuits. This arrangement provided three separate means of observing the different rates of alternation.

The tongues of the polar relays would vibrate back and forth between their contact stops under the action of the reversing currents passing through the relay coils, and the relays connected so as to actuate the sounders only by the contact on one side these latter would beat the complete periods of the two currents, for each goes at half the rate of its relay, and the lamps being in the sounder circuits will flash at the same rate that the sounders click.

At slow speeds the tongues of the polar relays could be plainly seen going one at twice the pace of the other, and the lamps would flash at different rates, every second flash of one coinciding with the successive flashes of the other, thus indicating plainly the double frequency of one circuit as compared with that of the other. Then by turning out one lamp the other sounder could be timed alone. By varying a resistance in the motor circuit, the machines could be slowed down so that the sounder of one machine would beat as low as half seconds while the other beat quarters, and the machines could be turned by hand at even a lower rate.

Another experiment proving the same thing but instituted for an entirely different purpose, and to which reference will be made later, deserves illustration as an instance of how results that are entirely unexpected may develop from a system of experimental circuits.

In Fig. 15, D_1 and D_2 are independent alternating

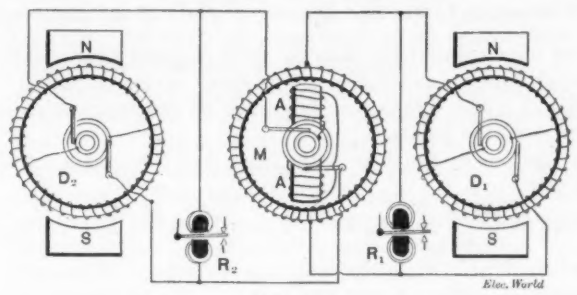


FIG. 15.

current dynamos having no immediate electrical connection. M is a third machine having its ring field circuit connected to the circuit of the first dynamo D_1, and its armature or revolving part is in circuit with the armature of the second dynamo, D_2. Polar relays R_1 and R_2 were placed in shunts to the two dynamo circuits as indicated.

The dynamo D_1 was then driven while D_2 was at rest. Both relays then vibrated in unison, though the dynamo D_2 was not given any current, but the alternating field of the machine M in circuit with the driven machine was acting as a primary to its armature circuit as a secondary, and thus sending a current of the same frequency through the circuit of the idle machine, D_2, and the polar relay in its circuit, causing it also to heat the alternations of the first machine. Leaving the second machine D_2 still at rest, the armature of the machine M was then driven in synchronism with the dynamo D_1 supplying its field. Evidently then the relay R_2 would beat at double the pace of the relay R_1, for we have again the conditions of the last experiment.

Theory of the Transformer.—VII.*†

BY FREDERICK BEDELL AND ALBERT C. CREHORE.

MAGNETIC LEAKAGE.

The action of a transformer, so constructed that the magnetic leakage may be neglected as being very small, has been developed in the previous sections of this article; and diagrams have been given showing the manner in which the electromotive forces and currents in the transformer change when the secondary resistance is made the independent variable. For such a transformer it appeared that the product of the coefficients of primary and secondary self-induction should equal approximately the square of the coefficient of mutual induction; that is, $L_1 L_2 = M^2$; and an example was given of an actual transformer in which the measured coefficients were so nearly in accordance with this relation that the approximation in considering that there was no magnetic leakage was very close indeed.

It is our present object to study the action of a transformer in which there is magnetic leak, which may have been introduced intentionally into the design for a specific purpose or which may have been found to exist for any unassigned reason, and to inquire into the effects produced by the addition of magnetic leak alone.

It will perhaps give as clear an idea of the effect of magnetic leak as can be exhibited in any other way to find what change is introduced into the geometrical diagram by this consideration. This brings before us the problem of finding how a diagram may be constructed in such a case. The answer is that there are in general two methods available for constructing the diagrams. We refer to the synthetical and analytical processes. We may either build up the diagrams synthetically from considerations similar to those given in previous articles of the series, or we may analytically obtain the solution of the problem directly from the differential equations, and then make diagrams to correspond to these solutions.

Here it may not be out of place to say that such an analytical solution from the differential equations, for a case even more general than that under our immediate consideration in that the solution is not limited to a harmonic impressed electromotive force, was presented by the writers in a paper‡ before the World Congress of Electricians at Chicago, 1893. If reference is made to the paper referred to it will appear that the order of the differential equations involved, and probably therefore the complexity of the results obtained, increases by the removal of any one of several conditions. For the simplest case (the one that has already been considered in these articles), the differential equations take their simplest forms, being of the first order; by removing the condition of no magnetic leak, the order is increased to the second; and if a condenser is introduced into the secondary in series, the order is again increased by unity; while the still further generalization made by the introduction of a condenser into the primary will raise the differential equation to the fourth order.

It may prove of advantage to give here the differential equations which relate to this case, together with the results of their solutions, referring the reader to the original paper for the complete discussion. It will enable us to see clearly how the consideration of no magnetic leak simplifies the problem. The differential equation, whose solution gives the primary current in terms of the electromotive force and the constants of the circuit, is:

$$(L_1 L_2 - M^2)\frac{d^2 i_1}{dt^2} + (R_1 L_2 + R_2 L_1)\frac{di_1}{dt} + R_1 R_2 i_1 = R_2 f(t) + L_2 f'(t). \qquad (60)$$

The corresponding equation for the secondary current is:

$$(L_1 L_2 - M^2)\frac{d^2 i_2}{dt^2} + (R_1 L_2 + R_2 L_1)\frac{di_2}{dt} + R_1 R_2 i_2 = -M f'(t). \qquad (61)$$

In these equations i_1 denotes primary current; i_2, secondary current, and the electromotive force e is expressed as any function of the time; that is,

$$e = f(t). \qquad (62)$$

The expression $f'(t)$ denotes the first derivative of $f(t)$; that is,

$$f'(t) = \frac{df(t)}{dt} = \frac{de}{dt}.$$

Now, if there is no magnetic leak, we have seen that $L_1 L_2 = M^2$, so that $L_1 L_2 - M^2 = 0$; the terms of the highest order [the second order in the equations (60) and (61)] vanish, leaving the resulting equation of the first order much simplified.

The solutions of these equations have been obtained in general without making any assumption as to absence of magnetic leak or the character of the electromotive force.

For the construction of polar diagrams we are merely concerned with a harmonic electromotive force, and in this case

$$e = f(t) = E_1 \sin \omega t, \qquad (63)$$

where ω denotes 2π times the frequency. The solution of the differential equation (60), with this supposition alone introduced, gives the primary current,

$$i_1 = I_1 \sin(\omega t + \Phi) \qquad (64)$$

where

$$I_1 = \frac{E_1 \omega^2 \sqrt{R_2^2 + L^2 \omega^2}}{\sqrt{\alpha^2 + \beta^2}} \qquad (65)$$

and

$$\Phi = \arctan\frac{\beta}{\alpha} + \arctan\frac{L_2 \omega}{R_2}; \qquad (66)$$

the values of α and β being:

$$\alpha = \omega^4 (L_1 L_2 - M^2) - \omega^2 R_1 R_2, \qquad (67)$$

$$\beta = \omega^3 (R_1 L_2 + R_2 L_1). \qquad (68)$$

The solution of (61) for the secondary current gives

$$i_2 = I_2 \sin\left\{\omega t - 90^\circ + \arctan\frac{\beta}{\alpha}\right\}, \qquad (69)$$

where

$$I_2 = \frac{M E_1 \omega^2}{\sqrt{\alpha^2 + \beta^2}}. \qquad (70)$$

Upon comparing the expressions for I_1 (65) and I_2 (70) we obtain

$$I_2 = \frac{M \omega I_1}{\sqrt{R_2^2 + L_2^2 \omega^2}}. \qquad (71)$$

This is the already familiar relation between the primary and secondary currents of a transformer, and it is evidently in accord with the generalized Ohm's law for harmonic currents. When we recollect that $M \omega I_1$ is the impressed electromotive force upon the secondary, and that $\sqrt{R_2^2 + L_2^2 \omega^2}$ is the impedance, equation (71) merely asserts that

$$\text{Current} = \frac{\text{Impressed electromotive force}}{\text{Impedance}}. \qquad (72)$$

These solutions give us a means of obtaining the geometrical diagrams (which will be done later) independently of any considerations of a synthetic nature, they being directly derived from the differential forms. It will prove interesting, however, to obtain the diagrams by each method above referred to and then examine whether they give accordant results.

DIAGRAMS COMPARED WITH ANALYTICAL RESULTS—CASE OF NO MAGNETIC LEAKAGE.

Let us compare the results already obtained by the synthetic method for the case of no magnetic leakage with the analytical result given in the equations above. When we equate $L_1 L_2 - M^2$ to zero, then the values of α and β, (67) and (68), become

$$\alpha = -\omega^2 R_1 R_2; \qquad (73)$$

$$\beta = \omega^3 (R_1 L_2 + R_2 L_1). \qquad (74)$$

Hence

$$\frac{\beta}{\alpha} = -\frac{L_1 \omega}{R_1} - \frac{L_2 \omega}{R_2}, \qquad (75)$$

and

$$\sqrt{\alpha^2 + \beta^2} = \omega^2 R_1 R_2 \sqrt{1 + \left(\frac{L_1 \omega}{R_1} + \frac{L_2 \omega}{R_2}\right)^2}. \qquad (76)$$

*All rights reserved.

†For previous section of this article, see THE ELECTRICAL WORLD, Oct. 7, 1893.

‡"General Discussion of the Current Flow in Two Mutually Related Circuits Containing Capacity." See "Physical Review," Vol. I, Nos. 2 and 3.

Substituting these values in (65), we obtain

$$I_1 = \frac{E_1}{R_1 R_2} \frac{\sqrt{R_2^2 + L_2^2 \omega^2}}{\sqrt{1 + \left(\frac{L_1 \omega}{R_1} + \frac{L_2 \omega}{R_2}\right)^2}}; \quad (77)$$

and upon substitution in (66), we obtain

$$\Phi = \text{arc tan} - \left(\frac{L_1 \omega}{R_1} + \frac{L_2 \omega}{R_2}\right) + \text{arc tan} \frac{L_2 \omega}{R_2}. \quad (78)$$

This value of Φ may easily be reduced to

$$\Phi = \frac{-\frac{L_1 \omega}{R_1}}{1 + \frac{L_1 L^2 \omega^2}{R_1 R_2} + \frac{L_2^2 \omega^2}{R_2^2}}. \quad (79)$$

Now the values of I_1 in (77) and of Φ in (79) exactly agree with the values of these quantities found from the geometry of the diagram constructed by the synthetic process, which have been previously given in these articles.* The difference in the sign of Φ given in the two places is due to the way in which it is derived, and may be either positive or negative, according as you are expressing the lag advance of the electromotive force ahead of the current, or the lag of the current behind the electromotive force, so that a difference of sign alone does not concern us here in showing agreement between the results.

MAGNETIC LEAKAGE CIRCUIT.

It seems essential in the first place, in discussing magnetic leakage, to consider again the magnetic circuit which was briefly treated in the first two articles of the present series.†

In saying that there exists magnetic leakage in a transformer we mean that all the induction generated by either primary or secondary circuit does not thread the other, so that an appreciable quantity of the flux due to either coil avoids passing through the other, going around it by another path. We are thus led to the idea of a divided magnetic circuit, and we might expect that the magnetic flux in such circuits would be analogous to the current flow in electric circuits, since the law of the magnetic circuit conforms so closely with Ohm's law for electric circuits.

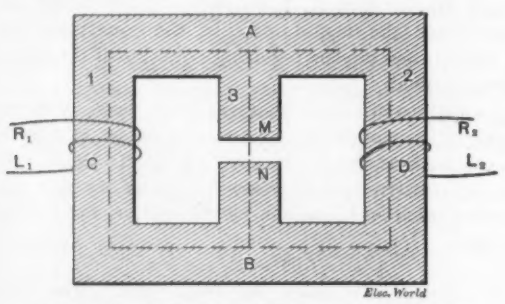


FIG. 24.—A DIVIDED MAGNETIC CIRCUIT.

Take a particular case, represented in Fig. 24, of a divided magnetic circuit composed of three separate branches, $A\,C\,B$, $A\,D\,B$ and $A\,M\,N\,B$. The section is taken parallel to the lines of induction. Let us suppose that the points A and B have different magnetic potentials, and that A has the higher potential. There will then be a continuous fall of magnetic potential from A to B, and there will be magnetic flux or induction from A to B, the greater part of which takes that path that has the least reluctance. Now if there were no magnetic material in the region between the points A and B, which for the moment we are supposing to be points of maximum and minimum potential respectively, the flux would spread out from A and converge to B in such a manner that the density of the flow at any point in the surrounding medium would change very gradually from point to point, it being the most dense on the straight line $A\,B$. But by introducing a path of iron between the points we should find that most all the flux passed through the iron in preference to the air, since it has a much less reluctance; by introducing more than one iron path the flux would divide among them inversely as their reluctances.

Let $\mathfrak{R}_1$, $\mathfrak{R}_2$ and $\mathfrak{R}_3$ denote the reluctances of the three branches $A\,C\,B$, $A\,D\,B$ and $A\,M\,N\,B$, respectively. The values of $\mathfrak{R}_1$, $\mathfrak{R}_2$ and $\mathfrak{R}_3$ depend upon the shape of the iron circuit as well as the kind of iron used, and in some cases it might be difficult to approximate to their values. But when the cross-section of the circuit is approximately uniform throughout, as in the case before us, these values may be expressed in terms of the dimensions of the circuits. In case of the circuit $A\,C\,B$ we might select a line $A\,C\,B$ (shown by the dotted line) as the main path of induction, and denote by l the average length of the lines of induction through $A\,C\,B$. If A_1 denotes the average cross-section, we have

$$\mathfrak{R}_1 = \frac{l_1}{\mu_1 A_1}, \quad (80)$$

where μ_1 is the permeability of the iron used. Similarly for the branch $A\,D\,B$ we should have

$$\mathfrak{R}_2 = \frac{l_2}{\mu_2 A_2}. \quad (81)$$

The reluctance of the branch $A\,M\,N\,B$, which is supposed to contain an air gap $M\,N$ with permeability equal to unity, would be found by adding together two portions, namely, the part through the iron and that through the air. Thus:

$$\mathfrak{R}_3 = \frac{l_1}{\mu_3 A_3} + \frac{l_a}{A_a}, \quad (82)$$

where l_1 is the mean length of the iron and l_a of the air circuit.

In any case, whether we can easily compute them or not, there will in general in any transformer exist these three magnetic circuits which we may say have the reluctances $\mathfrak{R}_1$, $\mathfrak{R}_2$ and $\mathfrak{R}_3$. If the transformer has little or no leak, we would say that $\mathfrak{R}_3$, the reluctance of the branch not containing the primary or secondary coil, is very great compared with $\mathfrak{R}_1$ or $\mathfrak{R}_2$.

The law of the magnetic circuit developed in the beginning of this series of articles is

$$\text{magnetic flux} = \frac{\text{Magnetomotive force}}{\text{Reluctance}}.$$

In symbols this is expressed

$$N = \frac{\text{M. M. F.}}{\mathfrak{R}}, \quad (83)$$

where N is the flux through that path whose reluctance is $\mathfrak{R}$, and M. M. F. the magnetomotive force between A and B measured by the line integral $\int H\,d\,l$ of the magnetizing force taken from A to B. This integral expresses the work done in moving a unit positive magnetic pole from B and A and is thus the difference of magnetic potential between the points.

The flux by the three paths from A to B would be respectively

$$N_1 = \frac{\text{M. M. F.}}{\mathfrak{R}_1}; \; N_2 = \frac{\text{M. M. F.}}{\mathfrak{R}_2}; \; N_3 = \frac{\text{M. M. F.}}{\mathfrak{R}_3}, \quad (84)$$

where M. M. F. is the common difference of magnetic potential between the points A and B. The total flux is thus:

$$N = \text{M. M. F.} \left(\frac{1}{\mathfrak{R}_1} + \frac{1}{\mathfrak{R}_2} + \frac{1}{\mathfrak{R}_3}\right). \quad (85)$$

If $\mathfrak{R}$ denotes the reluctance of a single circuit, which would just replace the three above, and allow the same magnetomotive force to cause the same flux, we should have

$$N = \frac{\text{M. M. F.}}{\mathfrak{R}}; \quad (86)$$

hence,

$$\frac{1}{\mathfrak{R}} = \frac{1}{\mathfrak{R}_1} + \frac{1}{\mathfrak{R}_2} + \frac{1}{\mathfrak{R}_3}, \quad (87)$$

the analogy of the equivalent resistance of a number of electric circuits in parallel. It was to be expected that this result must follow from the law of the magnetic circuit.

To apply this principle to the transformer, let us suppose that we have a coil of wire composed of S_1 turns upon the branch C, Fig. 24, and another of S_2 turns upon the branch D, these being the primary and secondary coils respectively. When a current is flowing in the coil S_1, a magnetomotive force is set up that causes the induction, all of which passes through C and divides at A, part going via D and part via $M\,N$ to B, and finally back through C, thus completing the circuit. The reluctance of this path is the sum of two parts, viz., that due to $A\,C\,B$ and that due to the combination of $A\,D\,B$ and $A\,M\,N\,B$, in parallel. Let $\mathfrak{R}'$ denote this total reluctance; then

$$\mathfrak{R}' = \mathfrak{R}_1 + \frac{1}{\frac{1}{\mathfrak{R}_2} + \frac{1}{\mathfrak{R}_3}} = \mathfrak{R}_1 + \frac{\mathfrak{R}_2 \mathfrak{R}_3}{\mathfrak{R}_2 + \mathfrak{R}_3} = \frac{\mathfrak{R}_1 \mathfrak{R}_2 + \mathfrak{R}_1 \mathfrak{R}_3 + \mathfrak{R}_2 \mathfrak{R}_3}{\mathfrak{R}_2 + \mathfrak{R}_3}.$$

Let P denote the numerator of this expression; then

$$\mathfrak{R}' = \frac{P}{\mathfrak{R}_2 + \mathfrak{R}_3}. \quad (88)$$

If $\mathfrak{R}''$ denotes the reluctance of the circuits $A\,D\,B$, plus the combination $A\,C\,B$ and $A\,M\,N\,B$ in parallel, we have in a similar manner

$$\mathfrak{R}'' = \mathfrak{R}_2 + \frac{\mathfrak{R}_1 \mathfrak{R}_3}{\mathfrak{R}_1 + \mathfrak{R}_3} = \frac{P}{\mathfrak{R}_1 + \mathfrak{R}_3}. \quad (89)$$

In considering magnetic flux we need to distinguish the flux through any particular branch caused by a current in either primary or secondary coil. Let the subscripts denote the branch through which the flux passes, and the accent denote the current to which it is due; thus, N_2'' means the flux through the branch $A\,M\,N\,B$ which is due to the secondary current alone.

When a current I passes through the primary coil the flux in the primary coil circuit due to it is found by the law of the magnetic circuit.

$$N_1' = \frac{4\,\pi\,S_1\,I_1}{\mathfrak{R}'}. \quad (90)$$

This flux divides A into two parts, $A\,D\,B$ and $A\,M\,N\,B$, which are inversely as the reluctances of the paths; that is, we have

$$\frac{N_2'}{N_3'} = \frac{\mathfrak{R}_3}{\mathfrak{R}_2}, \quad (91)$$

Hence it follows that

$$\frac{N_2' + N_3'}{N_3'} = \frac{\mathfrak{R}_2 + \mathfrak{R}_3}{\mathfrak{R}_2}, \quad (92)$$

$$\text{and} \quad \frac{N_2'}{N_2' + N_3'} = \frac{\mathfrak{R}_3}{\mathfrak{R}_2 + \mathfrak{R}_3} \quad (93)$$

But

$$N_2' + N_3' = N_1'. \quad (94)$$

Hence,

$$N_2' = \frac{\mathfrak{R}_3}{\mathfrak{R}_2 + \mathfrak{R}_3} N_1'; \text{ and } N_3' = \frac{\mathfrak{R}_2}{\mathfrak{R}_2 + \mathfrak{R}_3} N_1'. \quad (95)$$

Substituting the value of $\mathfrak{R}'$ given in (88) in the denominator of (90), we have:

$$N_1' = \frac{4\,\pi\,S_1\,I_1\,(\mathfrak{R}_2 + \mathfrak{R}_3)}{P}. \quad (96)$$

This flux, we have seen, divides at A and B into two portions, which may be found by referring to equations (95) and (96). The flux through the secondary due to the primary is:

$$N_2' = \frac{4\,\pi\,S_1\,I_1\,\mathfrak{R}_3}{P}. \quad (97)$$

The flux through the leakage branch due to the primary alone is:

$$N_3' = \frac{4\,\pi\,S_1\,I_1\,\mathfrak{R}_2}{P}. \quad (98)$$

In a similar manner, if we suppose a current I_2 to flow in the secondary coil, we should find the flux through the secondary to be

$$N_2'' = \frac{4\,\pi\,S_2\,I_2\,(\mathfrak{R}_1 + \mathfrak{R}_3)}{P}. \quad (99)$$

The flux through the primary due to the secondary is

$$N_1'' = \frac{4\,\pi\,S_2\,I_2\,\mathfrak{R}_3}{P} \quad (100)$$

The flux through the leakage branch due to the secondary is

$$N_3'' = \frac{4\,\pi\,S_1\,I_1\,\mathfrak{R}_1}{P}. \quad (101)$$

By means of these expressions, equations (96) to (100) inclusive, we are enabled to express the coefficients of induction of the transformer.

The coefficient of self-induction of the primary means the number of lines threading that circuit due to a unit current flowing in the primary. The induction passing through the primary magnetic circuit when a *unit* current flows is then $\frac{N_1'}{I_1}$. But this induction threads the primary coil S_1 times, once for each turn of wire, and this amounts to the same as if $\frac{S_1 N_1'}{I_1}$ lines threaded but a single turn of wire, and this is therefore the coefficient of self-induction if we are using the C. G. S. unit of current. We use in practice the ampère, which is one-tenth the magnitude of the C. G. S. unit of current, and hence the coefficient, when the current is expressed in amperes, is

$$L_1 = \frac{S_1 N_1'}{10\,I_1} = \frac{4\,\pi\,S_1^2\,(\mathfrak{R}_2 + \mathfrak{R}_3)}{10\,P}. \quad (102)$$

The secondary cofficient of self-induction is found in a similar manner to be

$$L_2 = \frac{S_2 N_2''}{10\,I_2} = \frac{4\,\pi\,S_2^2(\mathfrak{R}_1 + \mathfrak{R}_3)}{10\,P}. \quad (103)$$

The coefficient of mutual induction, interpreted to mean the induction through the secondary when a unit current flows in the primary, is

$$M' = \frac{S_2 N_2'}{10\,I_1} = \frac{4\,\pi\,S_1\,S_2\,\mathfrak{R}_3}{10\,P}. \quad (104)$$

The mutual induction, interpreted to mean the induction through the primary when unit current flows in the secondary, is

$$M'' = \frac{S_1 N_1''}{10\,I} = \frac{4\,\pi\,S_1\,S_2\,\mathfrak{R}_3}{10\,P}. \quad (105)$$

Hence, whether there is magnetic leakage or not, the coefficient M is the same whether we consider that it represents the induction through the secondary due to unit current in the primary, or whether it represents the induction in the primary due to unit current in the secondary, and we have

$$M' = M'' = M. \quad (106)$$

We see by the expression for M that it must decrease as the reluctance of the branch $A\,M\,N\,B$ decreases; that is, if there is a perfectly easy path for the induction across from A to B through $M\,N$ none will go through the path $A\,D\,B$.

The Electric Strength of Solid, Liquid and Gaseous Dielectrics.

Prof. Alexander Macfarlane and Mr. G. W. Pierce give in the "Physical Review" the results of some experiments made by them on paraffined and beeswaxed paper and on kerosene oil, to ascertain if the electrostatic gradient necessary to force a spark through these materials diminishes as the thickness increases. From the results of their experiments and others they conclude that thin strata of a liquid or solid dielectric are equally strong whatever the thickness, while thin strata of a gaseous dielectric grow weaker as the thickness is increased. The cause does not appear to be any surface phenomenon, but rather to be due to the greater rarity of the gas, which allows discharge by convection to be more readily set up. For the greater thicknesses convection is sometimes started in a liquid dielectric, and it is observed that the discharge itself takes place at a lower difference of potential. Viewed in the light of the mathematical theory electricity in equilibrium, it is the gaseous dielectric which is anomalous.

Applied Science.

The eminent scientist Pasteur says: "There is no applied science; there are sciences and the application of the sciences."

* See THE ELECTRICAL WORLD, May 6, 1893, page 340: "Theory of the Transformer.—III."

† See THE ELECTRICAL WORLD March 25, 1893, p. 224; also, THE ELECTRICAL WORLD April 8, 1893, p. 261.

How Galvanometer Coils Should Be Wound.

BY EDWIN F. NORTHRUP.

The following is an attempt to point out the best practical arrangement of the wire, and the methods of winding the coils for Thompson's reflecting and ballistic galvanometers.

We will first discuss the ideal results to be attained and then show how to proceed in order to reach the closest approximation in practice.

The proper resistance for the coils of a galvanometer patterned like a Thompson reflecting instrument, and which is to be used for detecting or measuring steady currents, may be determined as follows: First assume that the galvanometer has a cylindrical channel, and that it is desired to determine the proper gauge of the wire with which this channel is to be filled. Let y be the radius of the wire to be used, c the thickness of its insulation, and S the cross section of the channel made by a plane through its axis. The portion of the cross section filled by each turn, if the wire is wound in square order, will be $(2y + 2c)^2$, provided the spaces between the wires are included.

The number of turns in the channel will then equal $\frac{S}{(2y+2c)^2}$. If r be the mean radius of the cross section of the channel, the whole length of wire is approximately $\frac{2\pi r S}{(2y+2c)^2}$. If ρ denotes the specific resistance of the wire, the resistance of a unit length is $\frac{\rho}{\pi y^2}$, and the whole resistance, R, of the coil is $\frac{\rho r S}{2(y+c)^2 y^2}$. For a given current, C, the magnetic force at the center of the coil is proportional to the number of turns, and the magnetic force parallel to the axis may therefore be written $\frac{ASC}{4(y+c)^2}$ where A is a constant.

If E be the electromotive force of the generator, and R' its resistance plus that of the wires connecting it to the galvanometer, we have

$$C = \frac{E}{\frac{\rho r S}{2(y+c)^2 y^2} + R'}$$

and for the axial component of magnetic force

$$F = \frac{ASE}{\frac{2\rho r S}{y^2} + 4R'(y+c)^2}.$$

We can change the constant A to A_0 so as to make

$$F = \frac{A_0 SE}{\frac{\rho r S}{2y^2} + R'(y+c)^2}$$

ts maximum value when the denominator is a minimum. Differentiating the denominator and equating it to zero we obtain $y^4 + c y^3 = \frac{\rho r S}{2R'}$.

But for the resistance of the coil we have $R = \frac{\rho r S}{2(y+c)^2 y^2}$, and this used with the last equation gives $\frac{R}{R'} = \frac{y}{y+c}$, which means that the resistance of the coil should have to the external resistance the ratio of the radius of the bare wire to the radius of the wire when covered. With the graded coils, to be described, $\frac{y}{y+c}$ would be difficult to determine, and so, for all practical purposes, it is near enough to the truth to call C equal to zero and hence to say that the galvanometer resistance should equal the external resistance.*

The best ballistic galvanometers are now made with coils wound in a channel similar to that used for the coils of a Thompson's reflecting galvanometer, and we will now consider the best resistance for such an instrument when used to measure transient currents.

There are two distinct cases to consider, first, when the transient current is produced by causing lines of force to suddenly cut a coil of wire, as when the current is produced by an earth inductor, or as is done in permeability tests upon iron. Second, when the transient current is produced by discharging a condenser.

When a current is induced in a secondary coil by suddenly removing or putting into it MI lines of force, M being the co-efficient of mutual inductance, and I the steady current in the primary circuit, the total quantity, Q, of electricity set in motion in the secondary is $Q = \frac{MI}{R}$, R being the resistance of the secondary circuit.†

In the case considered here of a ballistic galvanometer in circuit with a secondary coil, the resistance of the circuit is made up of two parts, G, the galvanometer resistance, and S, the resistance of the secondary coil, and the leads to the galvanometer. The current, I, will equal $\frac{E}{R'}$, where E is the electromotive force of the generator and R' the total resistance of the primary inducing circuit. Hence

$$Q = \frac{ME}{(G+S)R'}$$

The force, F, acting upon the needle by the discharge of a quantity of electricity, Q, through the galvanometer, will be $F = QK$, K being the constant of the galvanometer. Hence $Q = \frac{F}{K}$, and $F = \frac{MEK}{(G+S)R}$. Now, if wire of n times smaller diameter be used in the galvanometer, and if we call the thickness of the insulation zero (which will give us a sufficiently close approximation for all practical cases), G will become $n^4 G$. For now the cross section of the wire has $\frac{I}{n^2}$ times its former value, and hence the resistance of an equal length of wire when its cross section is thus diminished will be increased n^2 times. But to fill the channel with wire of this smaller cross section n^2 times the length will be required, which makes the new resistance, as stated, $n^4 G$. As the value of K also depends upon the length of wire, K will became $n^2 K$, and we will have $F = \frac{MEn^2K}{(n^4 G + S)R'} = \frac{MEK}{\left(n^2 G + \frac{S}{n^2}\right)R'}$.

As the numerator is a constant, F is a maximum when the denominator is a minimum. Differentiating and equating to zero we get

$$2nG\,dn - \frac{2nS\,dn}{n^4} = 0, \text{ or}$$

$n^4 G = S$; but $n^4 G$ is the resistance of the galvanometer, while S is the resistance of the secondary coil.

Hence, when we assume the thickness of the insulation of the windings to be negligible, a ballistic galvanometer, when used to measure induced transient currents, should have practically the same resistance as the secondary coil in circuit with it. This resistance of the secondary in permeability tests is usually low, and hence a high resistance galvanometer is not best adapted to such work.

The answer to the question, What is the best resistance to give a ballistic galvanometer which is to be used for measuring discharges from a condenser of a given capacity? is rather difficult. I have done some experimenting to answer this question, but am not yet ready to publish my results. The problem is a very interesting as well as an important one, and I should like to see some opinions expressed upon it in the columns of THE ELECTRICAL WORLD.

Besides giving to the coils the best resistance, there are three important conditions which ought to be fulfilled: (1) The size of the wire should be graded in a special manner; (2) the channel filled by the different sizes of wire should be given a particular cross section; (3) the case at the centre of the coil should have a particular form. A full discussion of these three cases is much too lengthy for the limits of this article, and only the practical applications of the theoretical principles will be touched upon. The theoretical side is fully treated in Prof. A. Gray's work on "Absolute Measurements in Electricity and Magnetism," vol. II., part II., pages 371 to 376, also in Mascart and Joubert, vol. I.

(To be continued.)

* The above demonstration is taken, slightly modified, from Andrew Grey's "Absolute Measurements in Electricity and Magnetism." Vol. II., part II., pages 369 and 370.

† See Fleming, on "Alternating Currents," Vol. I., page 186.

Relation Between Increase of the Dimensions and Rise of Output of Dynamos.

BY ALFRED E. WIENER.

In THE ELECTRICAL WORLD'S Digest of Oct. 7 (p. 272) Mr. Hering, under the heading "Output as a Function of Size," gives an abstract of an article in the "Elektrotechnische Zeitschrift," by Mr. Ernst Schulz, in which the latter determines the 2.6 power of the increase in size as the practical average for the rise of output.

Since this exponent is a very important constant for practical dynamo calculation I have since studied the original article and find that the above average does not cover the practical ground sufficiently to be universally used, but think it necessary to apply different values of this constant for the different cases occurring in practice.

If the dimensions of two dynamos of the same type are in the proportion $1 : m$, the ratio of their outputs will be an exponential function of this ratio of size:

$$\frac{W_1}{W_2} = \left(\frac{1}{m}\right)^x, \text{ or } \frac{W_2}{W_1} = m^x.$$

If this exponent x is known for the various practical cases, the dimensions of any dynamo for a required output can, therefore, be calculated, from the dimensions and the known output of one machine of the type in question, from the formula

$$m = \left(\frac{W_2}{W_1}\right)^{\frac{1}{x}}.$$

If we express all the linear dimensions of the two dynamos in multiples of their armature diameters, d_1 and d_2, respectively, this equation for the multiple, m, gives directly the armature diameter of the new dynamo—

$$d_2 = d_1 \times \left(\frac{W_2}{W_1}\right)^{\frac{1}{x}},$$

from which, then, all other dimensions of the required dynamo can be obtained by multiplying d_2 by the respective multiple of d_1.

It is the intention in the following to determine the exponent x for different conditions, and to derive practical averages for use with the various practical cases.

I. Comparison of Two Dynamos of the Same Type.—Let

d = diameter of armature, in inches.

l = length of armature, in inches,
$= \alpha \times d$, if expressed as multiple of d.

h = radial depth of armature discs, in inches,
$= \beta \times d$, if expressed as multiple of d.

A = number of conductors around pole facing circumference of armature; A = number of armature turns for ring armatures; $A = 2 \times$ number of armature turns for drum armatures.

a = thickness of armature wire, in inches.

q = sectional area of armature conductor, in square inches,
$= \frac{a^2\pi}{4}$, for round conductors.

b = depth of armature winding space, in inches,
$= \gamma \times d$, if expressed as multiple of d.

n = number of slots in armature (= number of teeth).

s = width of armature slot, in inches.

t = depth of armature slot, in inches,
$= \delta \times d$, if expressed as multiple of d.

L = mean length of one armature conductor, in inches; L = mean length of one armature convolution for ring armatures; L = mean length of one-half convolution for drum armatures,
$= \varepsilon \times d$, if expressed as multiple of d.

S = surface of armature, in square inches,
$= \eta \times d^2$, if expressed by d.

w = number of watts of C^2R loss per square inch of armature surface, $w = \frac{C^2R}{S}$.

M = magnetic flux in armature; *i. e.*, number of useful lines of force emanating from one magnet pole.

v = conductor velocity, in feet, per second.

N = armature speed in revolutions per minute,
$= \frac{v \times 60}{\frac{d\pi}{12}} = 230 \times \frac{v}{d}$.

P = number of pairs of magnet poles.

p = number of armature portions, electrically connected in parallel; $p = 2$, for bipolar machines; $p = 2$ or 4, for four-polar dynamos, etc.

σ = saturation factor of armature iron,
$= \frac{\text{Actual nbr. of lines p. sq. in.}}{\text{Maximal nbr. of lines p. sq. in.}} = \frac{\text{Lines p. sq. in.}}{120000}$

σ = saturation factor of pole pieces,
$= \frac{\text{Lines p. sq. in.}}{120000}$, for wrought iron,
$= \frac{\text{Lines p. sq. in.}}{75000}$, for cast iron.

E = electromotive force generated in armature, in volts.

C = current strength of machine in ampères.

W = output of dynamo in watts.

Then the E. M. F. of any continuous current dynamo is

$$E = \frac{A \times M \times N \times P}{p \times 30 \times 10^8} \text{ volts,} \qquad (1)$$

and its current intensity:

$$C = \sqrt{\frac{w \times S}{\frac{1}{p^2} \times \frac{L}{12} \times A \times \frac{9.27 \times 10^{-6}}{q}}}$$

$$= 1140 \times p \times \sqrt{\frac{w \times q \times S}{A \times L}} \text{ ampères.} \qquad (2)$$

Formula (2) is obtained by putting $C^2R = w \times S$, and expressing the armature resistance, R, by the length and area of the conductor; 9.27×10^{-6} is the resistance, in ohms, of one foot of copper, one square inch area, at 60 degrees C.

The output, therefore, is

$$W = E \times C \text{ watts.}$$

In order to enable the comparison of the outputs of two dynamos of different size we have now to separate in (1) and (2) the constant quantities from those which have different values for two machines of the same type.

Since half the number of lines of force emanating from any magnet pole of a dynamo pass to the next pole of opposite polarity at one side, and the other half to the next pole at the other side, each of these halves passing through the full armature section, the magnetic flux, M, per pole, is equal to the double iron section of the armature, multiplied by the density of lines per square inch, thus—

$$M = 2 \times l \times h \times 120000 \times \sigma, \qquad (3)$$

or, if l and h are expressed as multiplies of d,

$$M = 2 \times \alpha \times B \times d^2 \times 120000 \times \sigma \qquad (4)$$

Furthermore, if we neglect the iusulation around the armature conductors, thus assuming the whole available winding space filled with copper, we obtain for *smooth* armatures:

$$q = \frac{d \times \pi \times b}{A} \qquad (5)$$

$$= \frac{d \times \pi \times \gamma \times d}{A} = \frac{d^2}{A}(\pi \times \gamma), \qquad (6)$$

for *slotted* armatures:

$$q = \frac{s \times t \times n}{A} \qquad (7)$$

An expression for s can be obtained by fixing the saturation factor at the bottom of armature teeth. Let us take 90 per cent., which is a good practical figure, then, if φ is the angle embraced by the pole piece, we have:

$$M = \frac{n \times \varphi}{360} \times \left(\frac{(d-2t)\pi}{n} - s\right) \times l \times 120000 \times 0.90;$$

hence, by comparison with (3)

$$s = \frac{(d-2t)\pi}{n} - \frac{360 \times 2h \times \sigma}{0.90 \times n \times \varphi}$$

$$= \frac{\pi}{n}\left(d - 2t - \frac{255 \times h \times \sigma}{\varphi}\right)$$

$$= \frac{d\pi}{n}\left(1 - 2\delta - \frac{255 \times \beta \times \sigma}{\varphi}\right) \qquad (8)$$

and, by combination of (8) with (7):

$$q = \frac{d\,\pi\,t}{A}\left(1 - 2\,\delta - \frac{255 \times \beta \times \sigma}{\varphi}\right)$$

$$= \frac{d^2}{A}\left[\pi\,\delta\left(1 - 2\,\delta - \frac{255 \times \beta \times \sigma}{\varphi}\right)\right] \quad (9)$$

Both (6) and (9) are, therefore, of the form

$$q = \frac{d^2}{A} \times (k) \quad (10)$$

Inserting (4) and (10) in equations (1) and (2), we obtain

$$E = \frac{A \times 2 \times \alpha \times \beta \times d^2 \times 120000 \times \sigma \times \frac{230\ v}{d} \times P}{p \times 60 \times 10^8}$$

$$= \frac{A \times d}{p} \times (.0184 \times \alpha \times \beta \times \sigma \times v) \quad (11)$$

$$C = 1140 \times p \times \sqrt{\frac{w \times \frac{d^2}{A} \times (k) \times \eta \times d^2}{A \times \varepsilon \times d}}$$

$$= 1140 \times \frac{p \times d}{A}\sqrt{\frac{w \times (k) \times \eta \times d}{\varepsilon}} \quad (12)$$

and therefore,

$$W = \frac{A \times d \times p \times d \times \sqrt{d}}{p \times A} \times \left(.0184\ \alpha\beta\sigma v \times 1140\right)\sqrt{\frac{w\,k\,\eta}{\varepsilon}}$$

$$= d^2\sqrt{d} \times \left(21 \times \alpha \times \beta \times \sigma \times v\sqrt{\frac{w \times (k) \times \eta}{\varepsilon}}\right) \quad (13)$$

Since α, β, γ, δ, ε, η, σ, (k), and v are constants for any particular type, we can write:

$$W = d^2 \times \sqrt{d} \times (K) \quad (14)$$

and, by comparing the outputs of two machines, 1 and 2, of the same type, we find:

$$\frac{W_2}{W_1} = \frac{d_2^2 \times \sqrt{d_2} \times (K)}{d_1^2 \times \sqrt{d_1} \times (K)} = \left(\frac{d_2}{d_1}\right)^{2.5} = m^{2.5}$$

The required exponent for the increase of output, consequently, is thus theoretically found to be

$$x = 2.5.$$

In this mathematical determination of x, however, the insulation around the armature conductor has been neglected. But since this insulation decreases the area, q, of the conductor, and, therefore, also the current intensity, C, of the machine, the actual output, W, will be less than that obtained by formula (13). Since, further, the larger a percentage of the winding space the insulation fills the smaller the armature, this difference between the actual and the theoretical output will be the greater, comparatively, the smaller the dynamo, and it follows that the exponent, x, varies with the size of the machines to be compared.

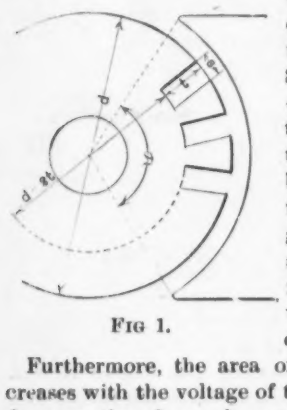


Fig 1.

Furthermore, the area of the armature conductor decreases with the voltage of the machine; in a high voltage dynamo, therefore, a larger portion of the winding space is occupied by the insulation than would be the case if the same machine was wound for low tension. From this it follows that the output of any dynamo, if wound for low voltage, is greater than if wound for high potential, and the value of the exponent x, consequently, also depends upon the voltages of the dynamos to be compared. We will now, by means of actual calculation, determine the influence of size as well as the influence of potential.

A Query.

In a recent after-dinner chat a question was asked which gave rise to a series of interesting queries. Suppose a glass jar containing an electrolyte be placed in the inside of a large coil through which an alternating current is passed, and suppose a smaller jar be placed inside of this one so as to leave an annular space filled with the liquid; the liquid will then act as a short circuited secondary. If the voltage and the current in the liquid answered the conditions required for the electrolysis of the liquid by alternating currents, what will happen? Would the liquid be electrolyzed, and if so, where and how will the deposits or the gases be formed? It would be a peculiar case of electrolysis without electrodes. If there is no electrolysis then there is a true conduction of electrolytes without electrolysis. Will the molecules "change partners," as they are supposed to do in every-day electrolysis? What will happen if a metallic plate be introduced vertically so as to compel the current to go from the liquid to the plate, and vice versa? As heat will evidently be developed, it has been suggested to use this method for cooking, but if electrolysis takes place might there not be danger of the formation of alkalies or acids in the victuals, which would not be pleasant to the taste, even if they did not spoil the food?

The Two-Phase System.

Dr. Bell recently said at Chicago, "When you have got an alternating current you can do something with it," to which Mr. Rankin Kennedy adds, "When you have got two alternating currents in quadrature you can do ten times more with them."

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

(Compiled from the principal foreign electrical journals.)

BY CARL HERING.

ELECTRO-PHYSICS.

Prof Lodge's Hypothesis.—Prof. Lodge, in the Lond. "Elec.," Oct. 27, replied briefly to Prof. Poynting's articles mentioned in the Digest, Oct. 21, 28 and Nov. 4; among other things he states that he sees no reason why atoms should not be perfect in conductivity, stating that the recent experiments of Dewar and Fleming on conductivities at very low temperatures seem to countenance the possibility of even an assemblage of atoms constituting a perfect conductor, if they are sufficiently nearly in contact with each other.

Transmission Through Air.—"La Lum. Elec.," Oct. 28, reprints the first part of an article from the Italian, by Mr. Vicentini, on "The Transmission of Electricity Across the Air Surrounding a Conductor Kept at a Red Heat by an Electric Current"; curves and records of experiments are given for both continuous and alternating currents; with a fine platinum wire spiral of 35 turns and a height of 14 mm., the potential of a platinum wire placed three millimetres from the spiral showed about seven volts for a current of 1.9 amperes.

Polarization of Platinum Electrodes.—"L'Ind. Elec.," Oct. 25, and "L'Elec.," Oct. 21, reprint an Academy paper by Mr. Colin on the "Influence of the State of the Surface of a Platinum Electrode on the Initial Capacity of Polarization," in which he shows the effect produced on the capacity by the evolution of the gases.

Relation between Optics and Electricity.—Mr. Blondin has an article in "Electricite," Oct. 19, in which he describes double electric refraction, rotary magnetic polarization and reflection from the poles of a magnet.

Coefficients of the Fundamental Formulas of Electricity and Magnetism.—Mr. Mercadier's article on this subject, mentioned before in these columns, is contained in full in the "Bul. Soc. Belge." for May, just issued.

Boundary Phenomena in Juxtaposed Solutions.—The Lond. "Elec. Rev.," Oct. 27, gives a short summary of these phenomena.

MAGNETISM.

Induction and Frequency.—"L'Ind. Elec.," Oct. 25, publishes the following table of Mr. E. Kolhen (Kolben?), which gives the maximum value of the induction adopted in the construction of alternating current apparatus within the limits required by good efficiency.

Frequency.	Maximum induction in C. G. S. units.
40	6,500 to 5,500
50	6,000 to 5,000
60	5,000 to 4,500
80	4,500 to 4,000
100	4,000 to 3,500
120	3,500 to 3,000

Magnetic Rotation Data.—The Lond. "Elec. Rev.," Oct. 27, calls attention to an article in the "Zeit. f. Phys. Chem.," Vol II., p. 753.

Commercial Magnetism.—A brief review of the serial in "Ind. and Iron," on this subject, which has been noticed in the Digest, is given in the Lond. "Elec. Rev.," Oct. 27.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Alternating Currents for Standardizing.—In a short article in "L'Elec.," Oct. 21, Mr. Meylan discusses the subject of the generation of small alternating currents for standardizing alternating current voltmeters; to do such standardizing by means of currents from large machines is very unsatisfactory owing to the vibration of the frequency and the voltage due to the irregularities in the speed of the engine. He obtained very satisfactory results in the laboratory of Mr. Hospitalier, by means of an electric motor driven by storage batteries; if, in a bipolar continuous current motor, two opposite commutator bars are connected to two rings in contact with brushes, an alternating current will be obtained, the frequency of which is equal to the number of revolutions of the armature; the voltage will depend on which of the commutator bars are chosen and on the magnetic field; if the bars are diametrically opposite the voltage will be a maximum, and the ratio of this to the continuous current voltage of the motor will depend on the form of the magnetic field; if it is uniform, and if the armature is perfectly symmetrical, the ratio ought to be equal to $\sqrt{2}$, which is the ratio of the maximum ordinate of a sine curve, to the mean ordinate, that is to the square root of the mean squares of the ordinates; in practice this will differ somewhat, and in the case cited below it was found to be 1.42 instead of 1.41; the only difficulty in this method is to obtain the necessary speeds for obtaining the frequency used in practice; a frequency of 60 (40 is the least that is used in practice) corresponds to a speed of 3,600, a frequency of 100 corresponds to 6,000 and a frequency of 125 (such as is used in the United States) corresponds to 7,500 revolutions; but as the power furnished is very small, being only several hundredths of an ampere, a small well constructed dynamo may be used without any danger; he used a small Perret (American) motor of about ½ h. p., intended to run at 1,600 revolutions with about 120 volts; 360 to 400 volts were required for a speed of 5,000 revolutions; as this is not practicable he introduced a liquid resistance in the field circuit, reducing the excitation to one-third or one-fourth, in which case 180 volts sufficed for a speed of 5,500 revolutions; by adjusting this rheostat the frequency may easily be varied; the brushes must, in this case, be adjusted with care to avoid sparking; by this means a simple, cheap and practicable apparatus is obtained, which, if used in connection with a transformer, will also give high voltages for electrostatic voltmeters. An abstract of this article, which however contains little that is not given here, is contained in the Lond. "Elec. Eng.," Oct. 27.

Proper Choice of Meters.—Mr. Claude, in "L'Ind. Elec.," Oct. 25, in an article on this subject, calls attention to the fact that when the current is used for lighting it is not the most rational thing to use a watt-hour meter, for if the potential falls but slightly the light will decrease much more rapidly, the light will therefore not be in proportion to the readings of the meter; when the voltage increases the cost of the lamps consumed would increase; in other words, such a meter measures the quantity of the energy but not the quality; in large installations where it is necessary to know the exact amount of the energy, as also when used for motors, it might be better to employ wattmeters, but for small installations he claims that it will be an advantage to use an ampere-hour meter, chiefly because they are very much cheaper; if both are the same price, he recommends the wattmeter, which, though not correct, is more nearly so than the ampere-hour meter.

Batault Meter.—The Lond. "Elec. Rev.," Oct. 27, publishes a translation of the description of this meter mentioned in the Digest Oct. 28.

Measuring Instruments.—Messrs. Niblett and Ewen continue their serial in the Lond. "Elec. Eng.," Oct. 27, on this subject; in the present portion they discuss the measurement of resistances by means of the differential galvanometer.

Resistance of Copper.—Mr. Legard's description of his redetermination, mentioned in the Digest Oct. 7, is contained in full in the "Bul. Soc. Belge." for May, just issued.

DYNAMOS AND MOTORS.

Theory of Rotary Field Motors.—In "La Lum. Elec.," Oct. 28, Mr. Boucherot gives the first part of an illustrated article on this subject; he believes that such motors are not receiving the attention that they should; after discussing the many contradictory statements regarding the theories, as advanced by different persons, he deduces some formulas based on what he thinks is the only rational way of treating the problem, in which he considers the circuits as having variable mutual induction coefficients and constant self-induction coefficients; this is followed by the results of some tests which he claims substantiate his theory, and which were made with a continuous current Gramme machine, connected so as to produce rotary field currents; the results are given in a number of sets of curves.

Cail-Helmer Alternator.—"L'Ind. Elec.," Oct. 25, gives a well illustrated description of this alternator, which in some respects is interesting, and appears to be novel; the armature is stationary and the field magnets revolve; each of the armature cores consist of sheet-iron pieces like two U's, thus UU, with one coil in common encircling the two cores' middle portions; the field magnets are similar in every respect, differing only in that the length of the coil is greater. Among the advantages claimed are the simplicity in the construction of the sheet-iron cores and the arrangement of the mechanical construction, which avoids the losses by Foucault currents in the framework, also that the air gap may be made very small, the excitation being only two per cent; one of the chief advantages claimed is that the parts may be easily taken apart for repairs; a short description is also given of a large flywheel alternator constructed on the same principle.

Edison Dynamo.—The Lond. "Elec. Eng.," Oct. 27, publishes a full page working drawing, with measurements, of an Edison dynamo for 50 kilowatts at 800 revolutions and 125 volts; the dimensions of the driving pulley are given in great detail, but there is no description and no data concerning the size and winding of the wire, a rather more important matter.

TRANSFORMERS.

Transformer with Variable Magnetic Resistance.—A somewhat novel form of transformer, devised by Mr. Helmer, is described briefly and illustrated in "L'Ind. Elec.," Oct. 25; it is multipolar, and is arranged so that by merely turning a handwheel the magnetic resistance may be varied; there are no magnetic joints except the two air gaps which are varied.

ARC AND INCANDESCENT LIGHTS

Lighting of Workshops.—In a paper on this subject, abstracted in the Lond. "Elec.," Oct. 27, and reprinted in full in the Lond. "Elec. Eng.," Oct. 27, including a cut of an inverted arc lamp, in which the mechanism is in the lower part of the lamp, Mr. Dobson calls attention to the requirements, and shows the great advantage

resulting from the use of inverted arc lamps, the light from which is reflected from a whitewashed ceiling, thus giving a diffused light casting no shadows. In an editorial note on this article it is stated that but little light is emitted from arc lamps at angles greater than 70 degrees with the axis of the carbon, and that a reflector to catch all the light within this limit should subtend a solid angle of 0.684π, that is, the radius of the reflector should be about three times the distance of the reflector above the arc; practically, however, the reflector should be as large as possible, in order to avoid shadows.

Mercury Pump.—The "Elek. Anz.," Oct. 22, describes and illustrates the new pump of Prof. Neesen; the advantages which are claimed for it being that it requires very little mercury, that owing to a multiplicity of the tubes the action is very rapid, that it is easily operated and that it is considerably cheaper than the usual vacuum pumps.

Candle-Power of Search Lights.—Editorial comments on this subject from the Lond. "Elec.," Oct. 27, will be found in full in another column of this issue; they indorse recent statements made in these columns.

Lamp Holders.—The Lond. "Elec.," Oct. 27, concludes its article on this subject, illustrating a number of English lamp holders.

Arc Lamps.—In his serial on the scientific study of arc lamps in the Lond. "Elec. Rev.," Oct. 27, Mr. Kennedy discusses the rack and pinion motion. In the serial of Mr. Richard, in "La Lum. Elec.," Oct. 28, he describes and illustrates a number of arc lamps.

TRANSMISSION OF POWER.

Transmission of Power.—The first portion of Prof. Unwin's third lecture, the subject of which is "Wire-rope Transmission," is given in full, together with a number of illustrations, in the Lond. "Elec. Eng.," Oct. 27. His fourth lecture on "Hydraulic Transmission" is abstracted in the Lond. "Elec. Rev.," Oct. 27.

Transmission from Tivoli to Rome.—"La Lum. Elec.," Oct. 28, continues, at some length, its illustrated description of this plant, including diagrammatic representations of the station, apparatus, and several views.

ELECTRIC RAILWAYS.

High Speed Railroading.—The "Electro Techniker," Oct. 15, contains an article on this subject by Mr. Birk, which, however, appears to contain nothing new.

Muerren Railway.—"L'Ind. Elec.," Oct. 25, gives a brief description of this mountain electric railway.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Two-Phase System.—Mr. Rankin Kennedy begins a serial in the Lond. "Elec. Rev.," Oct. 27, on "The New System of Alternating Current and Transformer Distribution," by which he appears to refer to the two-phase system; in the present installment he reviews briefly the history, origin, literature and progress, and describes the system as follows: "It is a universal system on which can be worked anything hitherto invented or which shall in the future be invented to work with continuous or alternating currents;" among other things he states that "electrical engineers do not seem to have 'caught on' to the advantages of the two-phase system, and are apparently totally blind to its possibilities, just as they were for many years to the transformer." He believes this system meets in every respect every requirement of a distribution system; he traces the history to the Woolwich dynamo of 50 years ago, also to the dynamo of Prof. Holmes, of 1857, both of which produced two alternating currents in quadrature, that is, one current is always at a maximum at the moment that the other is at a minimum; he gives a short summary of the literature on the subject, omitting, however, all reference to the Tesla motor or to the articles in The Electrical World in the year 1891; the article bids fair to be interesting.

Alternators in Parallel.—"La Lum. Elec.," Oct. 28, mentions that a German firm inserts a phase meter (that is an apparatus for measuring the difference of phase between the electromotive force and the current) in the circuit of each of the machines coupled in parallel, the excitation of each machine being then regulated so that this difference of phase is the same for all the machines, thereby avoiding the tendency to get out of synchronism.

Alternating Current Distribution.—Mr. Lucas, in the Lond. "Elec.," Oct. 27, calls attention to the importance of automatic apparatus for cutting out transformers when not in use.

Distribution.—In his serial in the Lond. "Elec. Eng.," Oct. 27, Mr. Guy discusses high pressure distribution, giving also relative figures for the two, three and five-wire low pressure systems.

Lightning Arrester.—The Lond. "Elec.," Oct. 27, describes and illustrates what is called the "Ajax" lightning arrester; it is constructed on the magazine principle and composed of 10 or more separate fusible lightning guards, which come into operation successively; each flash is earthed from a single guard, which it fuses, and in fusing places the next guard in circuit; a guard consists of a pair of fine brass wires about three inches long, lapping over each other three-quarters of an inch at the near ends with an air gap of one-twentieth of an inch between them, the lapped portion being inclosed in a sealed glass tube; one end is connected to the line and the other to earth; it is said to be simple and cheap; the successive connections are made by a loose piece of carbon, which drops from one fuse to the next as the wire is burnt out; it is applicable only to circuits using a ground return or ground wire.

High Tension Cut-Out.—The article of Mr. Leroy on his automatic switch described in the Digest, Oct. 7, is translated in the Lond. "Elec. Rev.," Oct. 27, accompanied by illustrations.

Zurich.—The Lond. "Elec.," Oct. 27, gives a short description of this station mentioned in the Digest some time ago; it includes a plan of the station.

Koenigsberg.—Lond. "Elec.," Oct. 20 and 27, gives an illustrated description of this station in which the five-wire system is used with accumulators.

Zoug.—"L'Ind. Elec.," Oct. 25, in its serial on Swiss stations, describes the lighting station in this small town.

WIRES, WIRING AND CONDUITS.

Insulation.—A correspondent to the Lond. "Elec. Rev.," Oct. 27, calls attention to the fact that too much stress appears to be laid on very high insulation for electric leads, stating that it is only a matter of cost, and that in most cases a much lower insulation resistance, but of much greater durability of the material, would suffice equally well and would cost much less.

Couplings for Wires.—In the "Elek. Anz.," Oct. 22, Mr. Haase describes a number of different couplings, showing, however, nothing of any importance or novelty.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Cryptography.—In the "Jour. Teleg.," Oct. 25, Mr. Anizan discusses the advantages and disadvantages of different systems of cryptography from the standpoints of economy, secrecy, rapidity and security of transmission and of subsequent translation; he advocates a system in which phrases are represented by number.

Pacific Cable.—The Lond. "Elec. Eng.," Oct. 27, reprints a notice from the London "Times" on the proposed Pacific cable, with which Mr. Sanford Fleming's name is connected.

Mandoux Telegraphic Switchboard.—The description of this switchboard is concluded in "L'Elec.," Oct. 21, in which a number of illustrations are given; the experiments made by the French telegraphic department seem to have given very satisfactory results, and have shown the advantages of this system.

Telegraph Statistics of 1892.—The "Jour. Teleg.," Oct. 25, publishes its annual record of the telegraph statistics for the past year.

Telegraphy in Great Britain for 1892-93.—The "Jour. Teleg.," Oct. 25, gives some statistical information.

ELECTRO-CHEMISTRY.

Primary Batteries in Theory and Practice.—The serial of Mr. Cooper on this subject is concluded in the Lond. "Elec.," Oct. 27; it includes a number of interesting curves for different cells, also cuts showing the construction of several dry cells. Regarding the depolarizers, he reports some experiments of Mr. Sprague, showing that a much greater quantity of electricity was obtained by using nitric acid than by any other substance; also that the difference in favor of sodium bichromate over potassium bichromate was very much greater than is generally supposed, notwithstanding the fact that the latter is more generally used; the actual ampere hours for the following substances (the quantity of which is not given) are as follows: Nitric acid, 16.0; chromic acid, 6.4; sodium bichromate, 5.0; potassium bichromate, 1.7. He divides cells into acid, neutral, alkaline and dry cells, giving briefly the characteristics of each.

Theory of the Accumulator.—Mr. Straintz, in the "Zeit. fuer Elek.," Oct. 15, continues his serial on this subject, describing certain calorimetric tests, to measure what he calls the Helmholtz heat, and which, he states, substantiates the theory of Helmholtz.

Forming Accumulator Plates.—When the formation of plates has been hastened by immersing them in nitric acid, a certain quantity of the acid will be retained in the pores, from which they will have to be freed; to accomplish this, Mr. Lucas, according to "La Lum. Elec.," Oct. 28, suggests to wash the plates in ammonia, and then to decompose the resulting ammonia salts by means of heat.

Aromatic Nitro-Compounds.—The Lond. "Elec. Rev.," Oct. 27, calls attention to an article of Mr. Gattermann, in "Berichte," Vol. 27, p. 1844, in which he shows that these compounds may be reduced by electrolysis, and that new compounds may thus be formed; they are dissolved in sulphuric acid and electrolyzed.

Electrolysis of Sea Salt.—The Lond. "Elec. Eng.," Oct. 27, gives a short description, taken from the French, of the Castner process, already described briefly in the Digest Oct. 7.

MISCELLANEOUS.

Action of Electricity on Microbes.—The Lond. "Elec.," Oct. 27, abstracts an article from the "Lancet, a medical journal, describing briefly some experiments of Messrs. d'Arsonval and Charrin, in which some of the cultures of the bacillus pyocyaneus were placed in the interior of a solenoid under the action of a current, while others were not under this action; there seemed to be no very marked difference, although there was some effect upon the organisms; the color of those acted upon being intensely green, which was much less marked in the others. See also the Digest Sept. 16. (Such an experiment would appear to depend very much on the position of the tube in the solenoid, as the action at the centre of the solenoid must necessarily be considerably less than near the coil; the action will also depend upon whether the currents induced can actually circulate, or, in other words, whether the liquid fills out the opening in the solenoid; the information given is not sufficient to see whether these conditions have been complied with.)

Ozone and Tuberculosis.—The "Lond. Elec. Rev.," Oct. 27, states that at a recent meeting of a French medical society, Mr. Herard read a very interesting paper on the treatment of tuberculosis by the inhalation of ozone, which has been applied successfully by Drs. Labbe and Oudin; numerous consumptive subjects who have been either completely cured, or greatly improved by this process during the last two years, he states, show that this treatment presents undeniable advantages.

Lightning.—From some statistics for the years 1879-85, it was found that of the number of trees struck by lightning, 11 per cent. were oaks, 70 per cent. beech and 19 per cent. fir trees; it is said that the relative conductivities of these woods are in about the same proportion; the tendency to be struck by lightning does not appear to depend so much on the water in the wood as on the oil contained in it; in the winter fir trees contain much fatty substance, but in summer they contain very little of it.

Thunderstorms.—The Lond. "Elec. Rev.," Oct. 27, contains an editorial on this subject, in which they offer the explanation that the electric charge is due to the friction between two currents of air which differ in temperature or in hygrometric condition; it describes in detail recently made observations of a storm which tend to prove the explanation offered.

Exhibition of Progress in Paris.—"La Lum. "Elec.," Oct. 28, enumerates the electrical exhibits at this exhibition without, however, giving any descriptions; one of the features of the exhibition is that the current for lighting and power is supplied from a central station about three and one-half miles distant in the form of an alternating current.

Electrical Education.—The Lond. "Elec. Rev.," Oct. 27, contains two letters to the editor on this subject. "L'Elec., Oct. 21, gives a brief description of the course in a French school for mechanics and firemen.

How Electricity Is Encouraged.

The Bishop of Urgel, in the Republic of Andorra, says the London "Electrician," a few weeks ago prohibited and anathematized the installation of telephonic apparatus and other supernatural and diabolical electrical sortileges. This interdiction of telephones, phonographs, etc., reminds one of the taboo which the Ediles of the Ville Soleil, Paris, inflicted on electricity and the electric light in 1853. Some induction coils were then installed in some wine and spirit shops, where shocks were administered to customers in a manner similar to the present automatic machines. The Municipal Council forbade the use of such electric machines, as being a source of accidents. A year later an inquiry was held on the treatment by electricity, which an electrician of the Conservatoire des Arts et Metiers was applying to cure some diseases. The Municipal Council of Paris decreed that the treatment by electricity was dangerous and suppressed it. This enlightened municipal council had, however, in 1851, authorized Archerau (who died this year in deepest misery) to use a battery of 60 cells on the Boulevard at the corner of the Rue Rougemont, for his electric lamp and electroplating experiments. The whereas of the decree was, that there was no risk of explosion or fire in using such a battery. The same intelligent body had also authorized the owner of a cafe to have an electric lamp on his premises, but on the express condition that the rays from the lamp should not fall outside, because they might frighten horses passing the cafe.

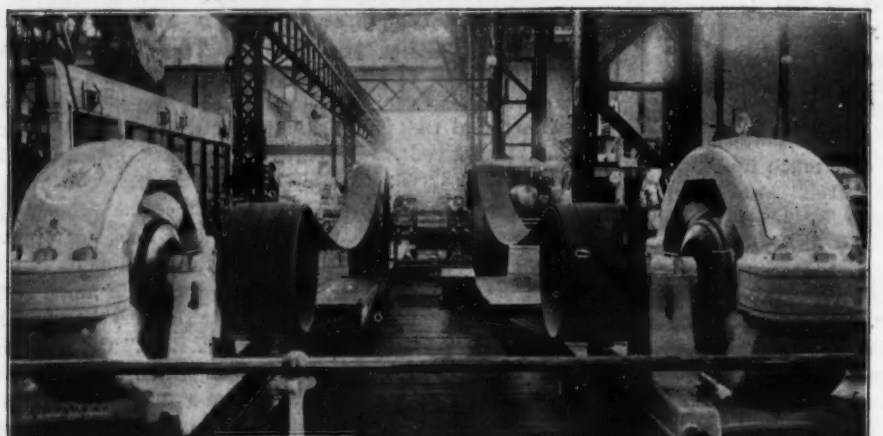
Continuous vs. Alternating Currents.

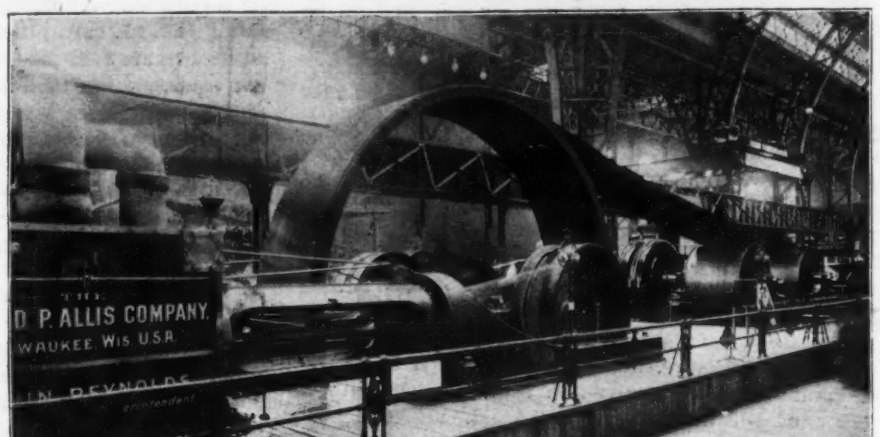
There are, as far as we know, says the London "Electrician," only three classes of individuals who are more or less bound to hold an impartial position toward the question of continuous versus alternating currents. These are presidents of scientific societies, ex-officio, consulting engineers, ex-professo, and editors of technical journals, coram publico. But this attitude is made difficult by the weak arguments which are put forward by advocates of alternate currents and transformers. Disregarding their own strong points and the really weak ones of the continuous-current system, they bring forward all sorts of side questions and new inventions when they undertake to discuss relative advantages and economies. It is very rarely that we find an alternate-current man who can point to a satisfactory plant and district and a good balance sheet and say, "This is all as it ought to be, and may be compared with a similar district supplied with continuous currents."

Page Belts at the World's Fair.

In the published records of the exhibits at the World's Fair and in the memories of the millions of visitors to the White City the Page Belting Company's display will take a prominent part. From the first this corporation determined to make its display remarkable in magnitude, excellence of the individual exhibits and general attractiveness, and it included such special features as the largest known pair of horns, the largest belts ever made, one three-ply, 102 inch wide belt of their "Crown" brand, 903 feet long, composed of 569 ox hides, weighing 5,176½ pounds, and the largest link belt ever made, 60 inches wide, three-quarters inch thick, 201½ feet long, composed of over 400,000 pieces of stock, and weighing more than two tons.

One of the finest pavilions in Machinery Hall was that occupied by the Page Belting Company, a beautiful building in imperial architecture, while the simple but classical





MAMMOTH BELTS IN OPERATION.

structure in Electricity Building, composed entirely of leather, representing belts designed especially for electrical work, was one of the most attractive at the Fair. But the most interesting and effective part of the company's display was the large number of belts of their manufacture in use all over the grounds, of which there were nearly 400, a large percentage of which were used for electrical purposes. One of the accompanying illustrations shows two mammoth tandem belts running from the large Allis engine to two Westinghouse generators. This cut was reproduced from a photograph taken while the belts were running at maximum speed under full load. These are three-ply belts, the shorter 72 inches and the longer 71 inches in width. These belts have a motion of 5,600 feet per minute and transmit more than 2,000 h. p., producing currents for upward of 20,000 incandescent lights of 16 c. p. each. These belts were the first to be started, as they were set in motion by President Cleveland on May 1, and during the entire Exposition have not been touched, but have performed their work in the most satisfactory manner. The running of such very large belts in tandem has never been undertaken before, and reflects great credit upon the character and quality of the belts. Various other belts furnished by the company are in constant use, all giving the best satisfaction, and among these were two 30-inch Acme link belts and many of the same style in narrower widths. The second of the accompanying illustrations shows two endless 18-inch Acme link belts running in Machinery Hall, from the Woodbury engine to the Mather power generators. This cut was also reproduced from a photograph taken when the belt was running at maximum speed under full load, the exposure in each case being more than 10 minutes. The perfect outlines of these belts show the remarkable steadiness of running of both the flat and link types.

FIG. 1.—BISMUTH FIELD EXPLORER.

The Page Belting Company secured two medals and two diplomas, one for flat belts and the other for Acme link belts, and thus carried off the highest honors awarded any of the belt manufacturers at the World's Fair.

The Bismuth Magnetic Field Explorer.

BY DR. TH. BRUGER.

In THE ELECTRICAL WORLD of March 12, 1892, there was published the description of an apparatus suitable for measuring magnetic fields, and I beg leave to draw attention to an instrument accomplishing similar purposes.

The magnetic field explorer based on the property of bismuth of varying its resistance in magnetic fields has come into such extensive use in Germany of late years that a description of the instrument and a discussion of its properties and capabilities may be of interest. This instrument has been brought out by Messrs. Hartmann & Braun, of Bockenheim, Frankfort-on-Main.

Its action depends on the property of the bismuth, discovered by Righi, of altering in resistance when placed in a magnetic field. The law of the relation of the resistance to the induction has been found by Leduc to be

$$f = a\sqrt{Z(Z+b)},$$

where f is the induction, or, as it is frequently called, the number of lines of force per square centimetre, and

$$Z = \frac{Rf - R_0}{R_0},$$

the variation of the resistance when the bismuth spiral is taken from a zero field where its resistance is R_0 to a field of intensity f, and a and b constants. Dr. Lenard has found that the best form for the bismuth conductor is a flat spiral wound double so as to be arranged non-inductively. The actual instrument is shown in Fig. 1. The bismuth employed is rendered chemically pure by electrolysis as the slightest impurities would impair the sensitiveness of the instrument very seriously. The bismuth wire is wound into a flat non-inductive spiral and enclosed between two plates of mica to protect it against any rough usage. The flat spiral is mounted in two strong copper rods which pass through the insulating handle to the binding screws.

The instrument is calibrated by being inserted in a field

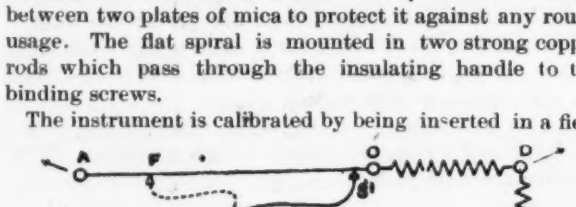


FIG. 3.—ARRANGEMENT OF WHEATSTONE BRIDGE.

whose intensity is known and can be regulated. Fig. 2 is a curve showing the relation between the increase of resistance and the induction. The ordinates are the variations in resistance and the abscissæ are induction in C. G. S. It will be seen from this curve that in weak fields Leduc's formula may be applied, but after the induction has reached 6,000 or so the curve becomes practically a straight line, which does not, however, pass through the origin if produced. The sensitiveness of this instrument is surprising.

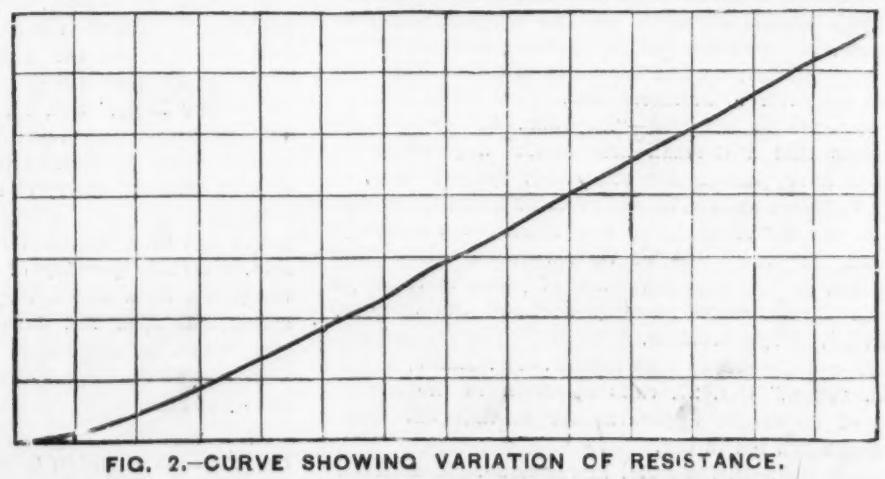


FIG. 2.—CURVE SHOWING VARIATION OF RESISTANCE.

It will be seen that in strong fields, such as those used in practice, the resistance of the spiral is nearly doubled. In the air gap of a dynamo it is increased some 30 to 50 per cent. When using the specific resistance of bismuth to determine magnetic fields, it is important to eliminate errors due to the rise of resistance caused by rise of temperature. In order to eliminate this, readings in the magnetic field and out of it may be taken in rapid succession, so that the temperature of the spiral of bismuth has not time to alter between the readings. The arrangement of Wheatstone bridge adapted for giving direct readings is shown in Fig. 3. $O\,D$ and $D\,C$ may be regarded as the ratio coils of the bridge, and are made up of equal resistances of one ohm. $O\,A$ is a stretched wire with a movable contact s_1. The other two of the four sides of the bridge are made up of the spiral of bismuth between the terminals a and b, and the resistance E and part of the slide wire going from it to B. To use the bridge the contact s_1 is put at O, so that the ratio elements of the bridge are equal. The contact s_2 is moved till there is no deflection on the galvanometer. This is when the resistance of the spiral is equal to that of E and the part of the slide wire included inside the contact s_2. The slide wire is thus used merely to add resistance to E to allow for the temperature alteration of the bismuth. The explorer is then put in the field to be measured. The resistance increases, so that the contact s is moved out toward A till a balance is shown. If the balance is obtained at F, for instance, the increase of resistance of the spiral is in the ratio of $F\,O$ to $O\,D$. As $O\,D$ is 1 ohm, $O\,A$ is also graduated in fractions of an ohm, so that the reading gives the increase of resistance, that is to say $\frac{Rf - R}{R_0}$ direct, without any calculations or references to tables.

Messrs. Hartmann & Braun have also worked out a piece of apparatus in which the rise of resistance of bismuth is utilized to give induction readings for testing iron.

An Electric Tower Clock.

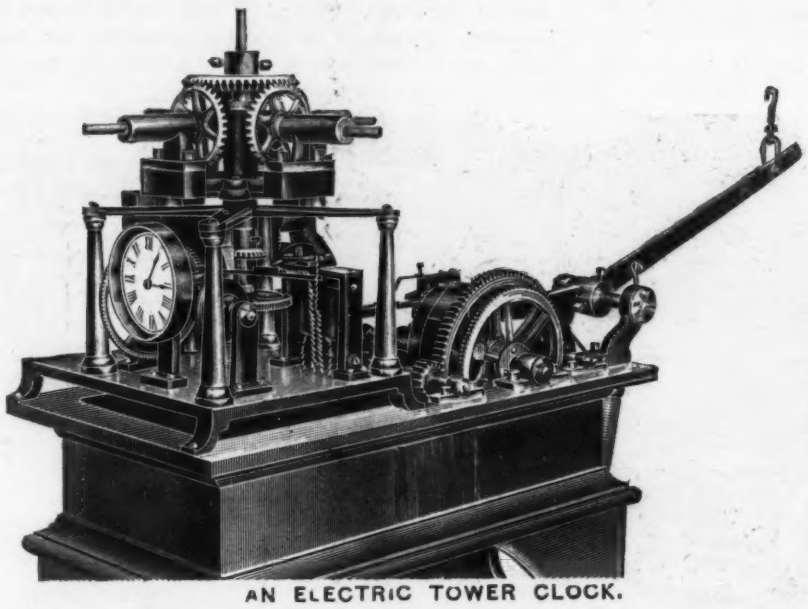
The electric motor has been made to perform a great variety of work formerly done by manual labor. Not only has it taken the place of horses for propelling street cars, and the small engine for driving machinery, but it is even in use in the church for furnishing wind for the organ, and to wind up the ponderous weights of the town clock. Among the most recent uses, is that made of it by the Standard Electric Time Company, of New Haven, Conn., in operating their tower clocks.

Two electric motors are used to operate this clock, which we illustrate. The motor used for driving the hands is connected by a gear and worm to an upright shaft, on the top of which is the usual gearing for the dial works. The motor circuit is closed every minute by a pair of magnets connected to a fine self-winding regulator, and after making the required number of revolutions to move the hands through a space of one minute on the dials breaks its own circuit, and there rests until the regulator closes the circuit on the next minute. A larger size motor is used to operate the striking mechanism, and its size varies according to the weight of hammer to be used. In this case the circuit is closed once an hour, and after striking the required number of blows breaks its own circuit, where it rests until the circuit is again closed.

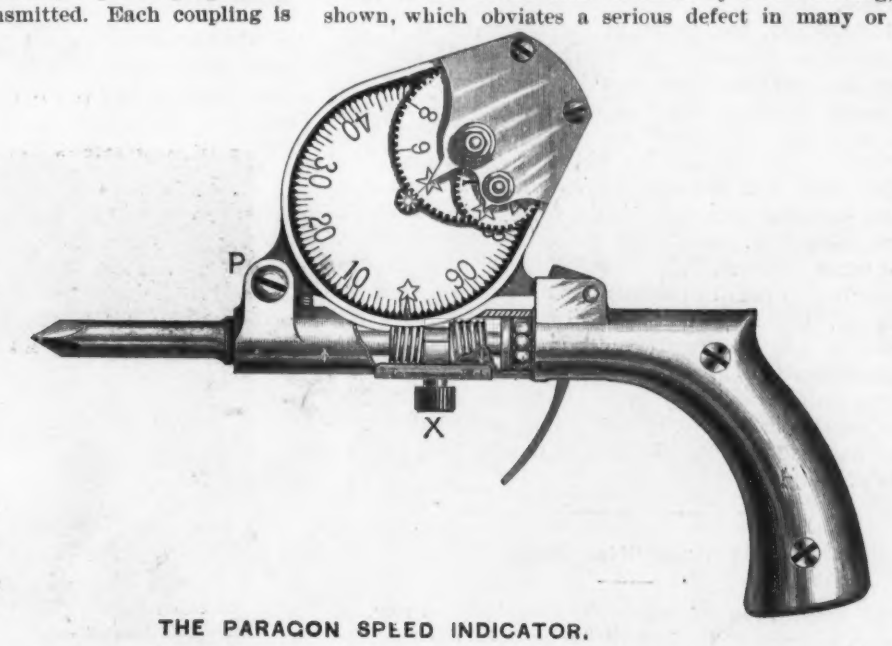
One of the most important features of this arrangement is the use of the ordinary open-circuit batteries for operating the motors. The motors are so wound that but a small amount of current is used, and they will last from one to two years without renewing the elements, which consist of only sal-ammoniac and zinc; and only ten cells are required for operating the hands of four six-foot dials. The number used for operating the striking mechanism varies according to the weight of the hammer used. The speed of these motors is very slow; the efficiency high, and so arranged that they will always start, even with a dead load.

Some realization of the labor saved by this arrange-

ment may be gained when it is understood that the ordinary tower clock, operating four pairs of six-foot pointers and striking the hours on a 1,000-pound bell, requires from 1,500 to 2,000 pounds of weight that must be wound up every eight days, besides the regulating necessary to keep it correct, which, owing to the extremes of temperature, makes accurate time impossible. By dispensing with the ponderous weights used in the ordinary clock, the weight in the tower is greatly reduced. The electric tower clock complete with stand will weigh about 400 pounds, while a weight clock suitable for similar work will weigh from 1,500 to 1,800 pounds, exclusive of weights. Another advantage also of this arrangement is the fact that secondary dials



AN ELECTRIC TOWER CLOCK.

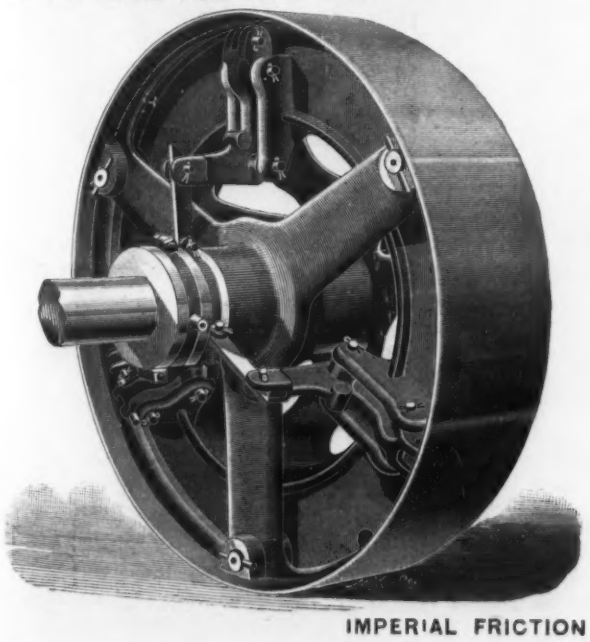


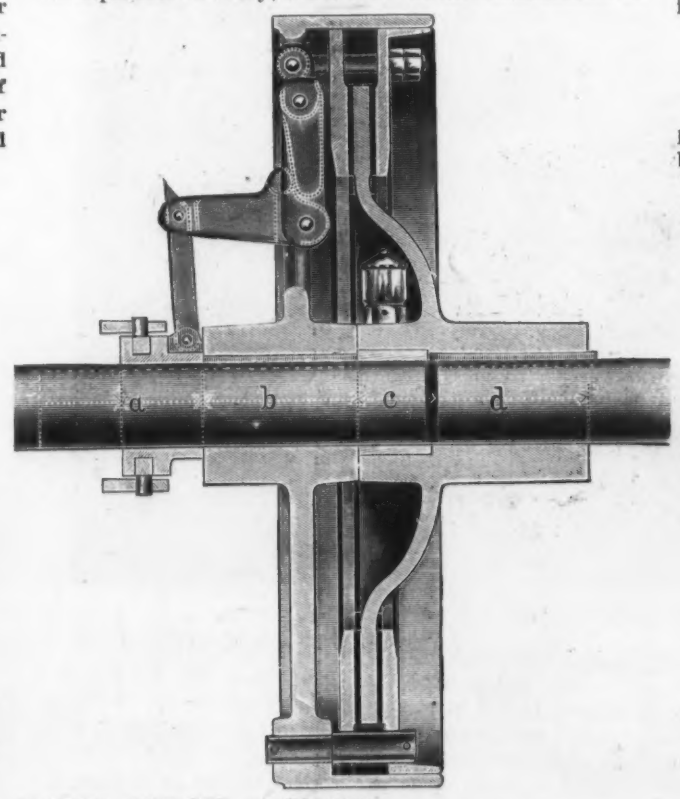
THE PARAGON SPEED INDICATOR.

may be operated throughout the building from the same regulator, which being placed in some office in the building where the temperature is comparatively the same will keep much better time than a clock that is placed in the tower and exposed to the great extremes of temperature. Both the time and striking machinery is very simple. Being operated directly by gears it is not liable to become disarranged in any way.

A Friction Clutch Cut-Off Coupling.

By the use of cut-off couplings lines of shafting are placed under immediate control, and can be instantly stopped or started. Two motors can be used on one line of shafting, both working at the same time or alternately, as may be desired. In elecuric plants, where a series of dynamos and engines are direct connected, sandwiching the dynamos between the engines and on both sides of them, such couplings afford a convenient means of shifting either the power or the load, as circumstances may require, driving all or a part of the dynamos with all or a part of the engines, or stopping part of the dynamos or engines without interfering with the operation of the balance of the plant. Occasionally, also, it may be desirable to run only a portion of the plant at times, as when making repairs or changes in a part of the works, and in other cases it may be desirable to run a portion of the plant over advantage, for where a section of shafting is discontime. In all such cases cut-off couplings are of decided nected, all belts and pulleys stop, making a saving of belting, bearings and oil, and also saving the power that would be required to keep shafting, pulleys and belts in motion when not at work.





IMPERIAL FRICTION CLUTCH CUT-OFF COUPLING.

Messrs. J. W. Penfield & Son, of Willoughby, O., have placed upon the market the Imperial Friction Clutch Cut-off Coupling, operated upon the same general principle as their well known Imperial friction clutch pulleys, which we described in our issue of July 22. The power is transmitted from one section of shafting to another by clamping a friction disc between two friction rings. The friction disc is keyed to one section of the shaft, and the clutch mechanism to the other. The friction rings in clutching the disc move parallel to the shaft, consequently centrifugal force cannot throw the coupling accidentally in clutch. Furthermore, the strain is in direct line with the resistance, consequently centrifugal force cannot throw the clutch out of balance. These features permit the running of the clutches at any speed. The friction surfaces of the friction rings are protected by strips of insulated fibre. These strips when worn can be readily and cheaply replaced. The couplings have three or six arms, depending upon the amount of power to be transmitted. Each coupling is neatly covered with a polished circular rim, like the rim of a pulley, thus greatly increasing the safety of the coupling, and reducing liability of accidents which would endanger life or limb. The coupling can be used as a pulley if desired.

A Printing Telegraph.

Mr. Donald Murray, a journalist employed on the Sydney "Morning Herald," of Sydney, New South Wales, has invented a printing telegraph by means of which it is claimed that a newspaper correspondent in, say, New York, may set type or work a linotype machine simultaneously in a dozen or more cities throughout the United States. The object of the invention, as described in the specification, is as follows: "To use only ordinary telegraph currents capable of being relayed, and subject to all the conditions of ordinary telegraphy; to operate at a distance any ordinary typewriting machine, or any typesetting or similar machine; to be able to transmit at least 80 different characters; to work at the utmost speed permitted by the manual dexterity of the operator working at a transmitting keyboard in all respects like that of an ordinary typewriter keyboard, and to dispense with all clockwork controlling mechanism, synchronously moving typewheels and other slow and cumbersome devices." The invention consists practically of a repetition of two simple elements, namely, a transmitting element (at the sending station), which, by the depression of a key, transmits a certain combination of five short positive and negative currents, and an intercepting element (at the receiving station), by the passage through which of a given combination of positive and negative currents a lever is released and makes electrical contact, thus energizing a particular electromagnet which operates a certain type key, only one interpreting element being completely unlocked by any given combination of currents. Thirty-two transmitting elements, connected in parallel form the transmitter, and 32 interpreting elements form the interpreter, and these combined with a shift key device, a typewriter and a battery, all suitably connected, comprise the essential features of the invention.

A New Speed Indicator.

We illustrate a very convenient speed indicator recently placed on the market by Messrs. Lintner and Sporborg, Gloversville, N. Y., under the name of the Paragon speed indicator, which combines several interesting principles.

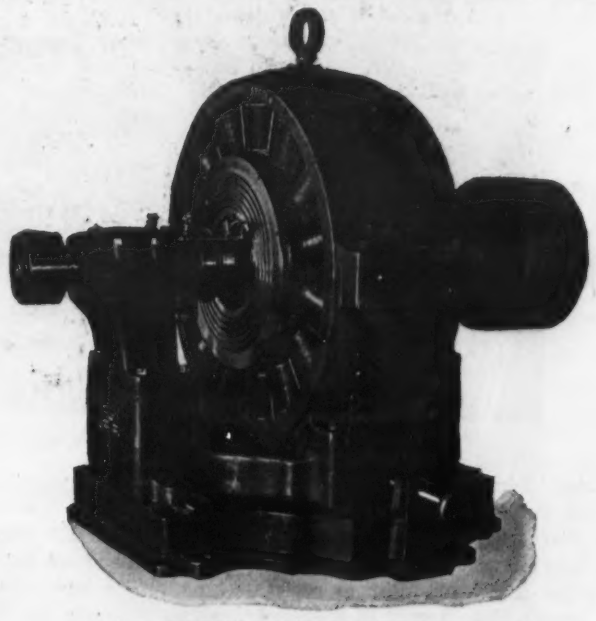
The thrust of the shaft is taken by a ball bearing, as shown, which obviates a serious defect in many or all other forms of indicators. There are two worms, one right and the other left handed, which slide longitudinally on the shaft, and either one may be thrown into gear by the shifter *X* on the barrel, which engages with the worms; by this means there is no confusion in the readings, as the dials move in the same direction for either right or left handed motion. The case containing the gears is pivoted at *P*, and by means of a spring they are kept normally out of mesh with the worm; at an exact instant the large gear is brought into mesh by means of the trigger *T*, and instantly thrown out when the pressure on the trigger is released. By this means the worm shaft can be properly entered into the countersink in the shaft of the machine to be indicated, and the reading begun at the most convenient instant and ended at the exact time. The pistol grip enables a firm and steady grasp to be secured. By means of a thumb nut on the back of the dial case the dials can be quickly brought to their zero position.

Testing Institution.

The first electrical testing establishment in Scandinavia has been opened at Stockholm, by Herr Azel Estelle, a well known Swedish electrical engineer. The establishment is modelled on the Physikalischtechnische Reichsanstalt, in Berlin, and undertakes the testing of electrical apparatus by instruments supplied by the institution, the draughting of plans for electrical installations, estimates, etc.

A New Alternator.

The accompanying illustration shows the 2,000-light pattern of the new La Roche alternator manufactured by the La Roche Electric Works, Philadelphia, Pa., which embodies all the most recent improvements. The electrical design of these alternators, both of the single and two-phase types, is such that while maintaining a practically constant potential from no load to full load, the iron losses have been reduced to a minimum, and by means of the greatly diminished air gap



LA ROCHE ALTERNATOR.

and close proximity of the armature coils to the magnetic circuit the electrical efficiency has been increased. The copper on the armature is said to be probably less than that of any other alternator on the market of equal output, for by an improved method of winding and placing the armature coils it has been found possible to entirely do away with the so-called "dead" wire on the armature.

Another novel and vital feature of the La Roche alternator is the method of connecting the armature, by which the potential between the different coils is greatly reduced below the total E. M. F. developed by the dynamo.

Mechanically, the design of the alternator is so proportioned as to render it remarkably stable and firm upon the foundation, but capable of perfect adjustment by means of heavy cast iron sub-bases provided with a belt tightener. The machines are provided with large self-oiling and self-aligning bearings of the ball and socket type, well babbited and provided with an automatic overflow with brass rings for securing a continuous lubrication. Another feature, the construction of the brush holders, will prove highly advantageous where it is required to suddenly lift the brush from the collector. Other details of construction have been perfected to meet the practical requirements of alternating current distribution, suggested after a trial of six years, during which time they have undergone modifications and readjustments, to embody what practical experience has undoubtedly dictated to be the best for this field of work.

A Large Mine Pump.

The application of electricity to mine service, although but one of the later departures in the field, has already attained a degree of perfection which allows it to become a formidable competitor to both steam and compressed air. This fact was ably demonstrated at the Chicago Exposition by the apparatus of the General Electric Company, which alone made a complete exhibit of mining electrical machinery.

The largest and most striking piece of machinery in this mining exhibit was a single reduction electric pump employed to furnish a head of water to a Pelton wheel in the exhibit illustrating the transmission of power by three-phase currents.

This pump is triplex double acting, having outside packed plungers, operated by means of crossheads and connecting rods, from an extra heavy forged steel crank shaft. It was designed for mine work, and has a capacity of 500 gallons per minute against 650 feet head. The plungers are of bronze, have a diameter of this fact is a matter of considerable importance when it is a question of installing pumps in the underground recesses of mines. Hitherto, pumps of this class have always been constructed with two sets of gears, but in this pump one set is economized by the slow speed of the motor, and a proportionate gain in efficiency effected.

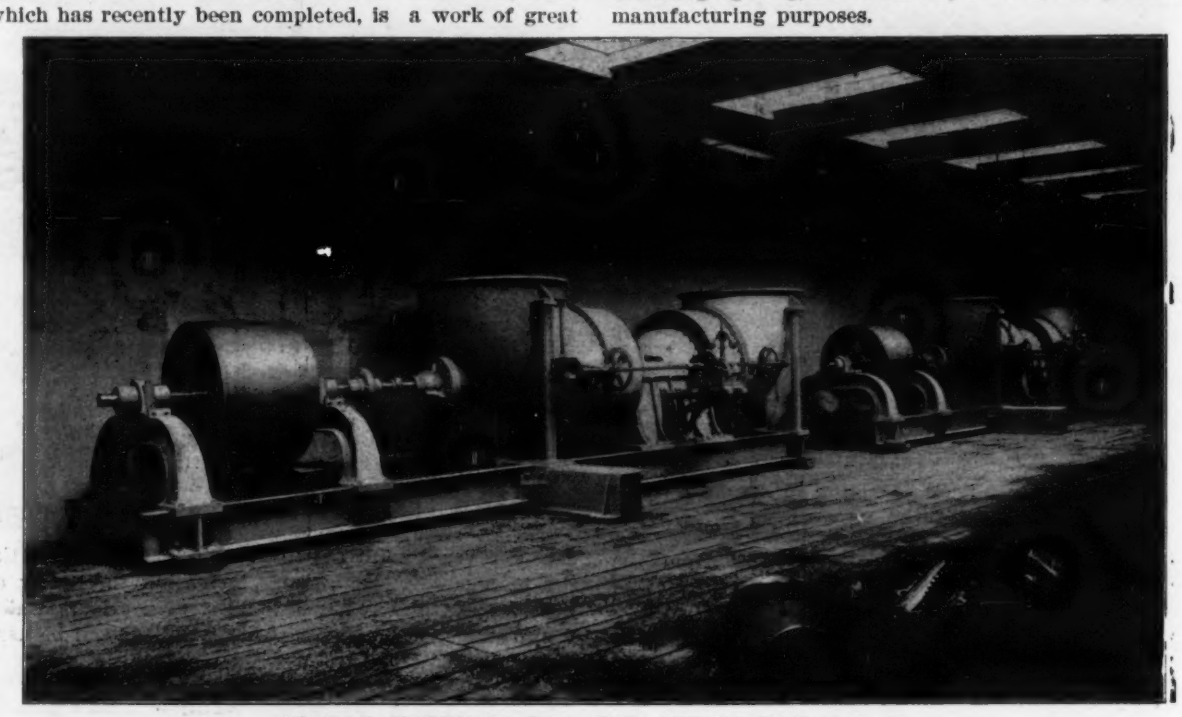
The pump throughout is solidly, substantially and extra heavily constructed and may be run for long periods without cessation at its full rated capacity. An electric pump of similar capacity to this has been for some time past operating successfully in the Calumet & Hecla mine.

A LARGE MINE PUMP.

The Austin Dam.

The dam across the Colorado River at Austin, Tex., which has recently been completed, is a work of great magnitude, and of much interest. This dam holds back a body of water forming a lake 24 miles long, furnishing water power that will add much to the future importance of Austin as a manufacturing centre.

The survey for the dam began in May, 1890; the contract for its construction was awarded in October of the same year, and the work of excavation was commenced at once; the first stone was laid in May, 1891, and the dam was completed in May of the present year.



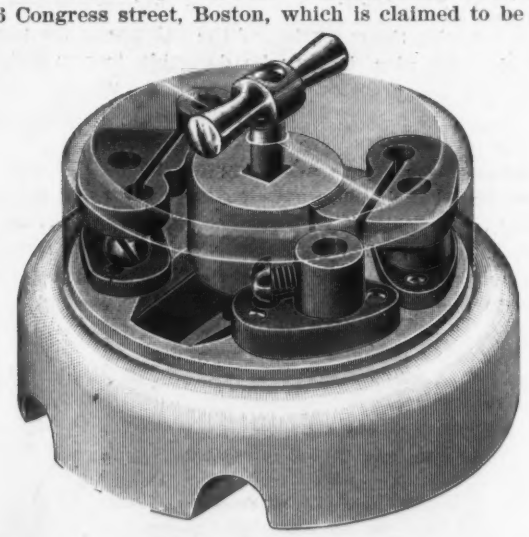
VICTOR TURBINES FOR THE AUSTIN DAM PLANT.

The pumps are horizontal double-acting ones of the plunger type, having two pump cylinders to each pair. They are driven by two vertical turbines of 200 h. p. each, under 54 feet head, the shafts being connected to the pumps by bevel gears.

The cost of the entire work, including reservoir, distribution system, power house and dam, is not far from $1,400,000, the pumps and turbines alone costing $70,000. About 40 miles of pipe, ranging in diameter from two feet to six inches, were required in the distribution system for the city water-works.

A New D. P. Switch.

We illustrate a new double pole switch, being placed on the market by the Iona Manufacturing Company, 336 Congress street, Boston, which is claimed to be the smallest switch made. The switch, as will be seen, is simple in construction, is easily wired, and has a larger carrying capacity than other switches of much larger size. Another thing that makes this switch popular with users is the fact that each switch is marked "On" and "Off," showing its condition at a glance.



DOUBLE POLE SWITCH.

Vertical Cross Compound Engine.

The accompanying illustration represents a vertical engine designed by the Ball Engine Company, Erie, Pa., and adapted especially for electric lighting and electric railway service. It will be built in several forms: Cross compound, triple and quadruple expansion. The view shows a cross compound vertical engine, the high pressure cylinder of which is 16 inches; low pressure cylinder, 28 inches; stroke, 16 inches, and revolutions, 240.

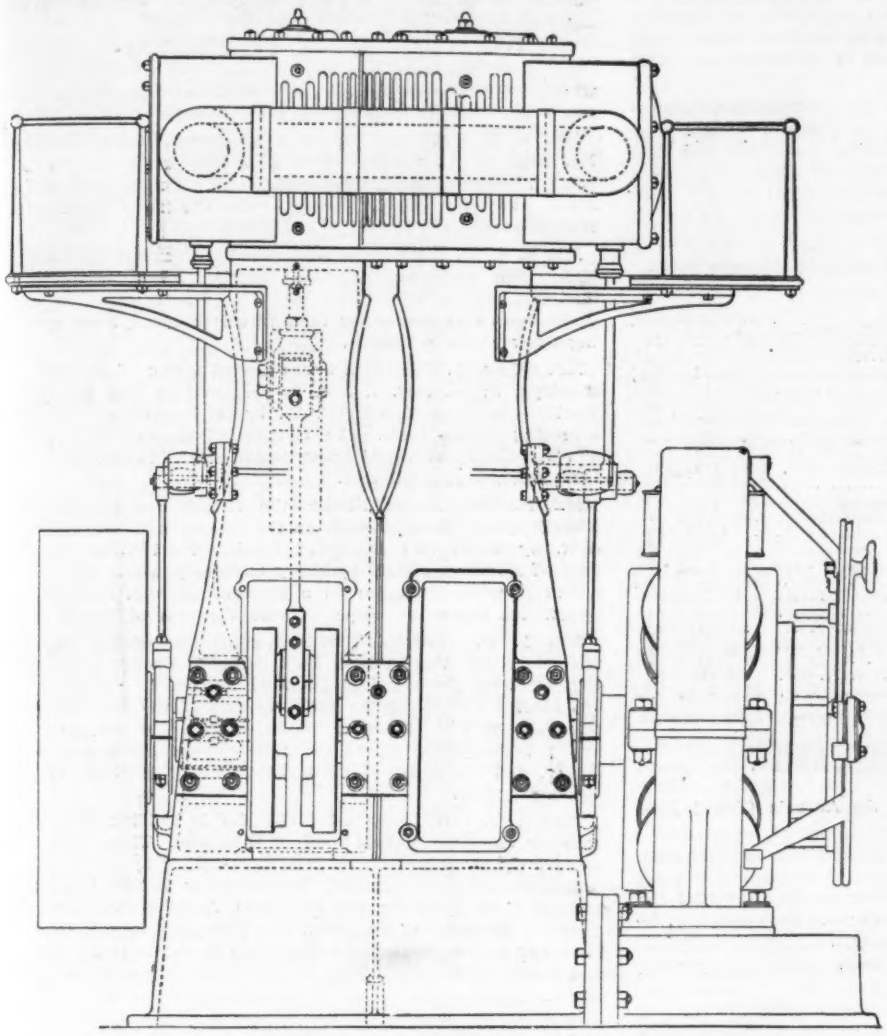
The engine being of the inclosed form has not only the advantage of cleanliness, but by its manner of construction all the parts are readily reached. For instance, the shaft boxes may be removed and the shaft

5⅜ inches, and are 18-inch stroke, and when operating at full capacity require 50 revolutions of the crank shaft per minute, giving a plunger speed of 150 feet. The cylinders and valve chambers are made of composition metal in order to resist the action of bad mine water. The pump is operated through a single set of gears by a General Electric six-pole 75 kw. motor, making 275 revolutions per minute. This necessitates a reduction of only five to one at the gears. The design of the pump is, in many respects, novel. The arrangement of the armature shaft, which is prolonged over the top of the pump, brings the motor to one side of the pump instead of in front, as is usually the case. By this means a great saving in space is effected, and

It is 1,150 feet long, 68 feet in height, 66 feet wide at the base and 16 at the top, cost about $608,000, and will furnish 14,500 h. p. for 60 hours per week. Both upstream and downstream faces are constructed of granite, and the interior is of limestone, all laid in Portland cement mortar, three parts sand to one of cement.

In the construction of the dam an overhead cableway 1,850 feet long, with a span of 1,350 feet, was used—the longest span of the kind ever operated. The cable was 2½ inches in diameter, and was suspended from towers on the bluffs on opposite sides of the river, the easterly tower being considerably higher than the other. The granite and other material were hoisted from a railway on the eastern side to the cableway

taken out without the disturbance of any other part of the engine, and with the greatest facility and ease. The valves are simple and durable. As originally fitted up they are absolutely steam tight, and owing to their construction continue to follow up their wear without any outside attention. The valve-driving mechanism is very simple and designed so that all necessary adjustments may be speedily and safely accomplished by attendants of average ability. Internal condensation is reduced to a minimum, and compression used to its greatest point of economy. The crank shaft is a solid steel forging from end to end, of ample proportions, and the crank shaft bearings are adjustable for wear. It is claimed for the governor that it will give practically perfect regulation, with almost entire freedom from wear and unequalled quickness of action. It is economical and cleanly in the use of oil, simple and durable, and noiseless in operation.



SECTION OF VERTICAL COMPOUND ENGINE.

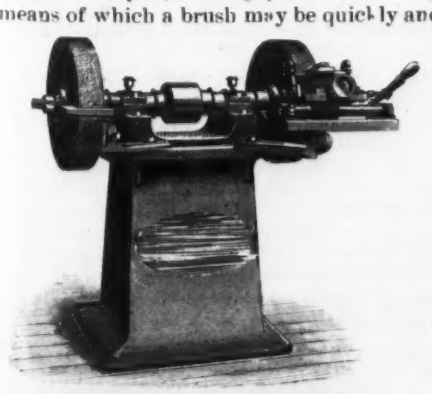
Commutator Preserver.

COMMUTATOR PREPARATION.

The engine from a mechanical standpoint is well designed as to distribution of material, and is thoroughly well built. The use of large and accurate tools in its construction allows the operation on each part to be originally perfect in itself. The engine is adapted for hard and constant service in the most trying situations, and it is claimed that for an equal transmission of power, either as a steady or a widely intermittent quantity, it has no superior in any form.

A Dynamo Brush Grinder.

We illustrate a dynamo brush grinder manufactured by the Springfield Emery Wheel Company, Bridgeport, Conn., by means of which a brush may be quickly and accurately ground to any bevel required. By means of a clamp, the rest may be adjusted to grind any size of brush, and the work is moved forward to the emery wheel by a screw with a milled head on the back of the rest. The work is passed over the face of the emery wheel by means of the hand lever at the right of the rest. This machine weighs 500 pounds. The height from the floor to the centre of the spindle is 37 inches, and the floor space is 20 by 24 inches. The length of the bearings is 5¼ inches, the diameter of the spindle in the bearing is 1¼ inches, and the distance between the wheels is 21 inches. The spindle is 32 inches long. Any size of emery wheel may be used up to 16 inches in diameter.



DYNAMO BRUSH GRINDER.

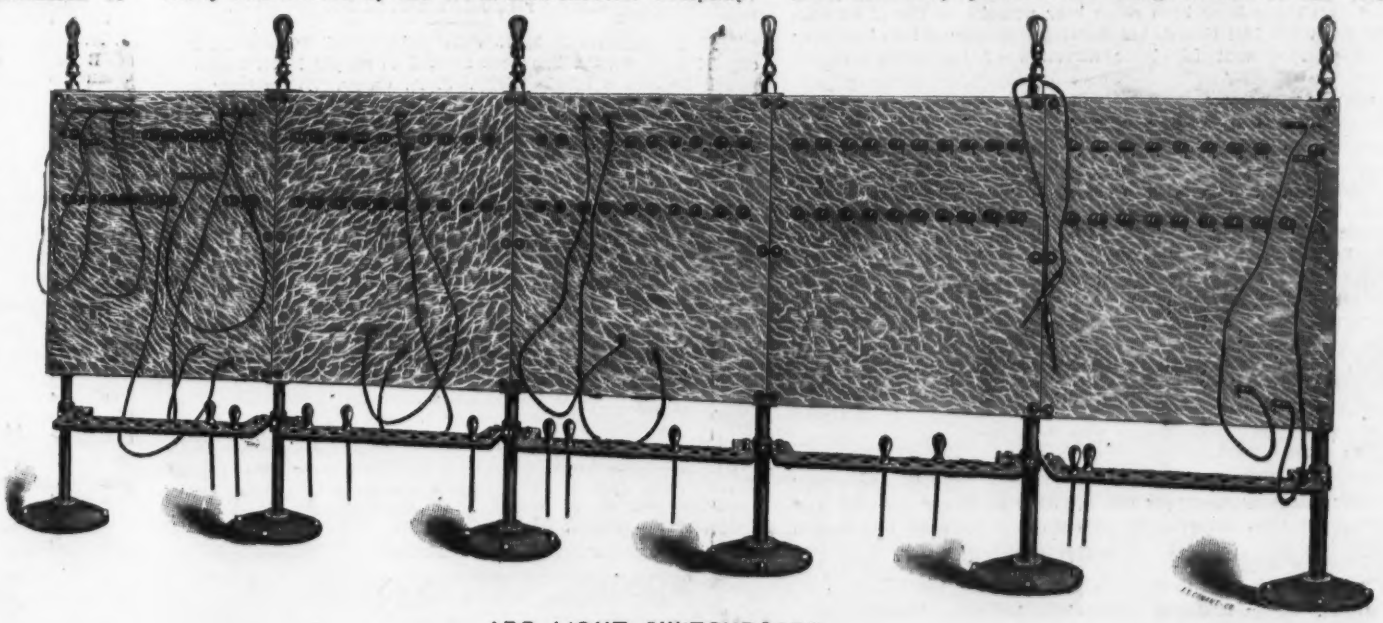
A Commutator Preparation.

Any one using carbon brushes knows the extreme difficulty in getting a perfect bearing of the entire surface of the brush that is supposed to rest upon the commutator, and it has been almost impossible to get a brush to bear properly until it has worn itself down in time. The E. G. Bernard Company, Troy, N. Y., has placed upon the market a preparation which they claim will, when a new brush is put upon the machine, at once build it up so as to have a full bearing on the commutator, there being a preparation in the compound that assimilates readily with the carbon brush and becomes a part of it. The preparation does away entirely with the use of oil or other grease and enables the dynamo tender to keep his machine always in a cleanly condition. It will besides prolong the life of both brushes and commutator by at least 50 per cent., it is claimed, and can be used with either copper or carbon brushes. The manufacturers, who have installed over 400 plants, state that they have used this preparation for some years in their own work, and therefore feel satisfied that their claims will be substantiated.

An Arc Light Switchboard.

We illustrate a 50 circuit arc light switchboard recently constructed by the W. S. Hill Electric Company, Boston, Mass., for the Narragansett Electric Lighting Company.

One of the prominent features of the switchboard is that all working and contact parts are blind fastened to the back side of the boards in the most rigid manner, thus avoiding the necessity of having bolts go through the board, so that there is no metal whatever on the face of it to appear unsightly or be dangerous to the operator.



ARC LICHT SWITCHBOARD.

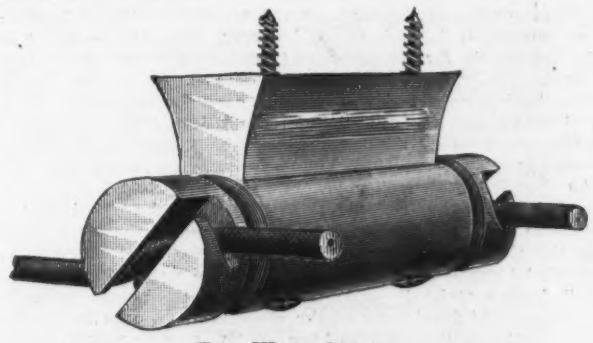
The Sterling Supply Company.

One of the most interesting exhibits at the recent convention of the American Street Railway Association at Milwaukee was that of the Sterling Supply Company, of New York. This display attracted a good deal of attention by the character and quality of the apparatus and its unique arrangement. The accompanying illustration gives a good idea of the exhibit, which included among other things the Sterling car heater, the Sterling register and the Sterling sand-box. Mr. J. Henry Carson, the president of the company, Mr. Howard Wheeler, general manager, and Mr. John Kennelly, engineer, were present and explained the construction and operation of their apparatus, which has met with such flattering success, although but recently brought to the attention of street railway men.

AN ATTRACTIVE EXHIBIT AT THE MILWAUKEE CONVENTION.

A Two-Wire Cleat.

An improved form of two-wire cleat has recently been placed upon the market by the Conover Insulator Company, Cincinnati, O. These cleats are made of vitrified china in one solid piece. They are self-tying, and this feature is not dependent upon the tension of the supporting screws. The danger of breakage is thus obviated, and they prevent the disfigurement of the ceiling by dust and smoke settling around the wire. The insulation of the circuit is also increased by preventing the contact of the wire with the ceiling. They are made of one size for No. 10 and smaller insulated wire. The annular tie wire groove of the common knob for dead ending purposes is retained.



TWO-WIRE CLEAT.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

New York, Nov. 11, 1893.

ELECTRICAL STOCKS have fallen somewhat in the background so far as any large participation in the general stock market is concerned. This does not by any means go to show that the electrical trade has not joined in the revival of business. On the contrary every day brings news of large orders having been placed, and the indications are that the volume of business to be done this winter will not compare unfavorably with what was accomplished in similar periods of previous years. But there has been a lack of genuinely speculative activity in electrical securities, with the consequent result of quotations not being materially altered by the week's operations or fluctuations.

GENERAL ELECTRIC matters have been unusually quiet. This company is generally the subject of so much gossip and talk, favorable and adverse, that a lack of rumors affecting the stock market value such as has been noticeable this week must be commented upon. It is, perhaps, not unjust criticism to say that many of the reports spread broadcast in the past were directly traceable to inside quarters, and that they were inspired solely for their effect upon the daily quotation of the General Electric stock. It may be hailed as a good sign then that so little news is now coming out regarding the stock. It was pointed out in previous letters that the company's officials had seemingly learned a lesson from its vicissitudes of the past summer, and had made up their minds that placing orders in the trade proper was a better way to make money than placing orders in brokers' offices. The management is seemingly applying itself to its proper work, with the result that there is once more a future for the General Electric Company. Thus it was announced this week that the People's and Electric Traction companies, of Philadelphia, would give to the General Electric Company the contracts for furnishing all motor and car equipments for the lines of these two companies. The total cost of equipping the cars will amount to something like $2,000,000. The General Electric Company has also secured the contract from the People's Traction Company for generators and a contract to supply the generators for the power house of the Tenth and Eleventh streets branch of the Electric Traction Company. Of course one hears a little once in a while of the old troubles besetting the company. The opposition to President Coffin, so violent at times last summer as to threaten the disruption of the corporation, has not died out, by any means, but it seems that the people heading it have been so thwarted and crippled in certain directions as to cry a forced halt; and a truce, how long to be kept no one knows, has been called in the internal warfare. November dividends are now irrevocably passed. When dividend payments are to be resumed no one knows, but the prospects are such as to assure an early resumption of the distribution of profits among insiders.

WESTINGHOUSE ELECTRIC quotations naturally retain the strength occasioned by the announcement last week of its good business record. The plant to be installed by it to generate electricity from Niagara Falls is to be of such enormous character as to allow of the distribution of electricity over an immense extent of territory. The power to be generated from the falls will be peddled out. This week there was incorporated at Albany the Cataract General Electric Company, whose ostensible purpose is to purchase and sell electric power in Monroe county. It is understood, however, that the company is formed mainly for the purpose of furnishing power on the Erie Canal. Among the directors is Thomas C. Platt, the Republican leader, and, in view of the fact that the Republican party will soon come into control of both branches of the State Legislature and most of the state offices, it is likely that Mr. Platt's company will be allowed to string its wires along the Erie Canal and furnish trolley motive power for canal boats under patents owned by and plants furnished by the Westinghouse Electric Company. It is also said that one of the electricians of the Cataract General Electric Company is connected in an official capacity with the Westinghouse people. This would still further make it evident that the Westinghouse Electric Company will furnish all of the electrical apparatus in the development and distribution of the Niagara electric power.

WESTERN UNION'S FLUCTUATIONS this week have not been of a character to indicate unusual circumstances. Mr. George Gould has returned to New York and has given his intimates assurances that the company is again making as much money as ever, the retrenchment in expenses having made up for the losses occasioned by less business and damage from storms. There have been some bear attacks on the stock during the week just closed, but nothing has occurred to base any decided movement in either direction of the stock's quotation.

THE AMERICAN DISTRICT TELEGRAPH COMPANY'S BOARD OF DIRECTORS, at a meeting held on Thursday, declared a dividend of one per cent. on the stock; it is payable on Dec. 18. No dividend was paid at the last meeting, because of the falling off in gross earnings during the summer months, but the reduction in operating expenses has made possible the present distribution of profits. The treasurer reports that since the first of November there has been a decided improvement in the volume of business. The new electrical department recently established for the care of electric bells, burglar alarms, etc., will prove, adds the treasurer, a source of large profit to the company. It now has 30,000 subscribers in New York City. There is renewed talk that the system will soon be taken by the Western Union Company, but so far nothing more than talk has developed.

THE EDISON ELECTRIC LIGHT COMPANY, of Chicago, has had its revenues threatened by the privilege granted by the Chicago City Council to the Mutual Electric Light and Power Company to supply electric light or power anywhere on the south side, hitherto the exclusive domain of the Edison Electric Light Company. The proposition of the city to buy the million dollar World's Fair electric light plant also proves a disturbing factor. In consequence of all this threatened competition, the stock, during recent days, has depreciated in value.

THE CENTRAL AND SOUTH AMERICAN CABLE AND TELEGRAPH COMPANY will have to compete soon on certain of its land lines with a new telegraph line soon to be opened between Buenos Ayres, Argentine Republic, and Valparaiso, Chili. There is a project on foot, however, to unite its South American lines with the Mexican telegraphic system by continuous land lines through Central America.

AMERICAN BELL TELEPHONE stock has dropped several points in the Boston market on heavy realization sales brought about by forced liquidation on the part of an operator in need of funds.

THE FORT WAYNE ELECTRIC COMPANY has taken no further steps toward completely breaking away from the General Electric Company. Mr. R. T. McDonald, the treasurer and soul of the company, is involved in the Madison Square Bank trouble, and it will need all his time and money to straighten out his bank affairs, so that the plan of the Fort Wayne people to have their own distributing offices in the South and West must wait a little while.

THE COMMERCIAL CABLE is to lay a third cable. The report that Mr. Mackay wanted to sell the Postal Telegraph Company to the Western Union people grew out of the fact that a good deal of money is needed to lay the cable contemplated and it was said that Mr. Mackay could not get the necessary funds except by selling his Postal Telegraph stock. As recited here last week, Mr. Mackay denies the story and sates that he has and can get all the money he needs to lay the new cable.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	20	40
Detroit Electrical Works			3
East River Electric Light	100	40	65¾
Electric Con. & Supply Co. pref.	15	15	16
" " " " " com	15	15	17
Edison Electric Ill., New York	100	97	98
" " " 1sts		104	105
Edison Electric Ill., Brooklyn	100	90	95
" " " Boston	100	115	124
" " " Chicago	100	220	230
" " " Philadelphia	100	120	125
Edison Electric Light of Europe		2½	5
" Bonds		80	85
" Ore Milling		5	12
Fort Wayne Electric		4⅛	5
General Electric Company	100	42	42¼
" " deb. 5's		79½	80
Interior Conduit and Ins. Co	100	25	35
Mount Morris Electric			65
Westinghouse Consolidated	50	25½	26
" " pfd	50	41	43
Cleveland General Electric Co		80	87
Western Union Telegraph	50	87¾	90⅞

AFFAIRS OF THE COMPANIES.

JOHN B. WALLACE, receiver of the Ansonia (Conn.) Electric Company, has resigned.

THE WENSTROM ELECTRIC COMPANY, at Calverton, Md., started up on Nov. 6 with a force of 40 men. The plant has been idle over two years. President Smith says that the prospects are very bright for the future. The company, he said, is figuring on several snug contracts.

THE CONSOLIDATED CAR HEATING COMPANY, Albany, N. Y., organized in August, 1889, reports that the sales have just passed the million dollar mark; the total at the close of business on Nov. 14 being $1,003,598.89. These figures show perhaps more clearly than anything else the progress the company has made and the esteem in which its appliances are held by railroads throughout the United States and Canada.

THE NATIONAL ELECTRIC MANUFACTURING COMPANY'S plant at Eau Claire, Wis., was sold on Nov. 1 by Receiver R. E. Rust to Peter Truax, of Eau Claire, at $7,500. This does not include any of the manufactured product. It is a question if the judge will confirm the sale, as the appraiser's figures put the value of the plant at a much higher amount. The books last May showed the plant to be worth $82,000, and it was recently appraised at $32,000.

NIAGARA FALLS, N. Y.—President Hunt, of the Pittsburgh Reduction Company, has made arrangements for the construction of their immense aluminium plant. They are the first to lease electric power. The Briggs Manufacturing Company of Niagara Falls has been organized in Wheeling, W. Va., with $1,000,000 capital. They will make the Briggs patent press feeder. Boston, Toronto and Dayton, O., men are interested. The plan includes the consolidation of the Morrison stitching machine interests.

THE COMPLETE ELECTRIC CONSTRUCTION COMPANY, 121 Liberty street, New York, has elected the following officers: Mr. John A. Seely, president and general manager; Mr. W. H. Baker, of the Postal Telegraph Company, vice-president; Mr. C. O. Baker, Jr., of Baker & Co., platinum refiners, secretary and treasurer; Mr. Geo. G. Ward, of the Commercial Cable Company, and Mr. Geo. F. Porter, secretary of the National Electric Light Association, directors. Mr. Baker retains his interest in Baker & Co., and his position there will be unaffected by his connection with this company.

NEW INCORPORATIONS.

THE PITTSBURGH ELECTRIC COMPANY, Pittsburgh, Pa., capital stock $5,000, has been formed to supply light, heat and power by means of electricity. J. A. Curry, Wilkinsburg, and W. H. Warwick, Bellevue, Pa., are the promoters.

THE WANOOSNOR POWER COMPANY, Fitchburg, Mass., capital stock $20,000, has been formed to furnish electric power for mechanical and manufacturing purposes. D. Simonds, G. M. Holman and A. T. Gifford are the promoters.

THE DEMING LAND AND WATER COMPANY, Deming, N. M., capital stock $700,000, has been formed to construct electric light plants, etc., etc., in Deming. The interested parties are P. C. Smith, S. C. Hobart, C. F. Thayer, J. L. Van Arsdale and C. F. Easby.

THE BUTTERMILK FALLS ELECTRIC COMPANY, Highlands, N. Y., capital stock $15,000, has been formed to manufacture and use electricity for light, heat and power. C. F. Roe, G. W. Flood, Highland Falls, and W. C. Anthony, Newburgh, N. Y., are the promoters.

THE MANITOU ELECTRIC RAILWAY AND CASINO COMPANY, Manitou, Colo., capital stock $125,000, has been formed to construct, operate and maintain a system of electric street railways, etc. M. A. Leddy, J. Hurlbert, S. King and H. L. Cable, of Manitou, Colo., are interested.

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-176 Times Building, New York, Nov. 13, 1893.

THE MAYOR has reappointed Jacob Hess, Theodore Moss and Walter Storm as subway commissioners.

MR. W. T. M. MOTTRAM has become general sales agent for the Curtis Electric Manufacturing Company.

MR. WILLARD L. CANDEE, of the Okonite Company, sailed Saturday last on the "Lucania," of the Cunard line. Mr. Candee expects to return in January.

MESSRS. DOUBLEDAY, MITCHELL & CO. are shipping a considerable amount of goods to Cuba. They report their business in canvas jacket goods and canvasite wire as improving.

THE ALEXANDER, BARNEY & CHAPIN stock of electrical supplies, fixtures, etc., has been removed to 67 Cortlandt street, where it will be on general sale, until entirely disposed of. Mr. D. Chalmers is in charge as representative of the receiver.

MR. W. M. SHEEHAN, of the Hyer-Sheehan Motor Company, Newburgh, N. Y., has just taken a contract for erecting a 150-h. p. water power plant, to transmit current for light and power seven miles, for the Buttermilk Falls Electric Company, at Highland Falls, N. Y.

MR. T. R. M'LEOD, of McLeod, Ward & Company, 91 Liberty street, New York, was married Wednesday, Nov. 8. Mr. and Mrs. McLeod, to whom The Electrical World offers its congratulations and wishes for their future prosperity, are spending a few weeks in Canada.

MR. CHAS. A. SCHIEREN was elected mayor of the city of Brooklyn, N. Y., Nov. 7, last, as predicted by The Electrical World in its issue dated Oct. 21, by a handsome majority, exceeding 32,000 votes. The electrical fraternity in general and The Electrical World in particular extend to Mr. Schieren their hearty congratulations.

MR. HARRY ALEXANDER, the electrical contractor, 126 Liberty street, is suffering from the effects of a serious accident, by which two fingers of his left hand were severely crushed a few days since by heavy machinery which was being set in place by workmen on a contract on which he is engaged. He hopes to escape without the loss of the fingers.

MR. A. W. STEDMAN, managing director of the Newton Rubber Works, was in New York during the week to close a contract with the Standard Railroad Equipment Company, of 143 Liberty street, for the exclusive sale of the Hubbell electric lantern and types of batteries made under the Hubbell patents. These rights cover New York State and New Jersey, and the mines of Pennsylvania along the lines of the Reading system.

THE J. W. FOWLER CAR COMPANY is building 25 18-foot cars for the Lake Roland road of Baltimore. These cars are exceedingly handsome, being finished in mahogany, with heavy bronze trimmings throughout. The company is also making a number of sweepers for the Baltimore Traction Company, the Traction Company of Scranton, the Newark & South Orange road, and others, including sweepers to go to Hartford, Conn., and Newburyport, Mass. Two of their latest improved sweepers are for the Brooklyn City & Newtown road, while the Atlantic Avenue road of Brooklyn takes 10 sweepers. Among the numerous sales recently made by Mr. Geo. S. Whipp, selling agent for the company, 26 Cortlandt street, New York, is an order taken last week for 26 cars to go to South America.

PITTSBURGH NOTES.

Pittsburgh, Pa., Nov. 11, 1893.

THIEVES BROKE into the warerooms of the West Newton Electric Light Company recently and stole a hundred 16 c. p. lamps and 75 sockets. The goods are supposed to have been taken to Pittsburgh.

THE PITTSBURGH ELECTRIC COMPANY has been chartered with the State Department at Harrisburgh; capital $5,000. The directors are James A. Curry, William H. H. Warwick, Robert A. Johnston, William M. Gillespie and Edwin L. Allen.

A FIRE OCCURRED in Mansfield, O., recently and did considerable damage to the power house of the Mansfield Citizen's Electric Street Railway Company, amounting to about $10,000. The road was equipped with the Westinghouse electric system. The operation of the line will be interrupted for a few days.

THE CANONSBURG ELECTRIC LIGHT COMPANY, of Canonsburg, Pa., was recently organized. The officers are John L. McClelland, president; Samuel McWilliams, secretary, and John S. Speer, treasurer. The company has secured a contract for five years from the Canonsburg borough for lighting the streets with arc lights, the rate to be paid for the lights being $60 per lamp per year.

THE ANNUAL MEETING of the board of directors of the Birmingham Traction Company, of this city, was held a few days ago and organized with the following officers: H. Sellers McKee, president; C. M. Clark, vice-president; T. J. Tener, secretary; Daniel Beach, treasurer; C. M. Clark, J. Milton Duff, J. H. Bakewell, executive committee; J. M. Wittengill and D. Z. Brickell, incline committee; T. H. Given and C. M. Clark, finance committee.

A LARGE FIRE in the city of Pittsburgh recently destroyed the buildings of the Cold Storage Company, and the Chautauqua Lake Ice Company, and dangerously threatened the central station of the Allegheny County Light Company situated quite close to the former. Fortunately, however, there was no damage done to the light plant, and the only inconvenience suffered by the company and the public existed in a temporary darkness of two hours caused by the cutting of some of the lines.

THE FIRST CAR was run Nov. 1 over the completed tracks of the McKeesport & Wilmerding electric railway. The road is five miles long and connects two of the most thriving little manufacturing towns in western Pennsylvania. The road is equipped with the Westinghouse electric railway system. A special feature of the line is, that the Adams Express Company has made an arrangement with the railway company by which the latter carries express packages, and for this purpose special express cars have been built and will be operated.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., Nov. 11, 1893.

THE NEW ENGLAND TELEPHONE AND TELEGRAPH COMPANY has declared a dividend of 75 per cent. per share, payable Nov. 15, 1893.

THE BOSTON CARWHEEL COMPANY, 620 Atlantic avenue, is getting out a handsome desk calendar and blotter. If you want one put in your application.

EAST HARTFORD ELECTRIC LIGHT AND POWER COM-

PANY.—This is the name of a new organization which has recently bee effected. The officers are the following: P. S. Bryant, president; A. C. Liebert, secretary, and L. S. Forbes, treasurer.

THE F. E. BELDEN MICA MINING COMPANY is erecting a large quartz and feldspar mill, and expects to have it completed within a few days, and by Jan. 1 will be able to fill orders. This company has just declared the regular monthly dividend, which will be paid Nov. 20, 1893, to stockholders of record Nov. 17, 1893.

MR. J. B. SARGENT reports the following sales of Stirling water tube boilers since Oct. 1, 1893: L. A. Riley & Co., Centralia, Pa., 250 h. p.; Simpson & Watkins, Scranton, Pa., 300 h. p.; J. I. Case Threshing Machine Company, Racine, Wis., 300 h. p.; Adriance, Platt & Co., Poughkeepsie, N. Y., 250 h. p.; Midland Street Company, Muncie, Ind., 400 h. p.

DARIEN, CONN.—A meeting was held to consider the proposition of the Stamford Street Railway Company to build an electric line to this town, and a committee was appointed to investigate and report at a future meeting. Rev. Arthur Roqua, Robert S. Purdy, Chas. W. Raymond, Alex. Mackey and Franklin Jones are the committee. President Fosdick, of the company at Stamford, will give details.

THE UNIVERSAL ELECTRIC COMPANY has recently been organized by a few gentlemen of Boston, for the purpose of maunfacturing primary batteries under patents owned by the company. The business offices of the corporation are located in the Equitable Building, its corporate office being in Portland, Me. Its factory is on Broad street, Boston. The battery owned by this company has aroused much interest among our best electricians here, several of whom having been permitted to make their own tests and examine the battery at will. The tests made for the owners have been made entirely by Mr. Kellogg, of the Whitney Electrical Instrument Company. Some of the results from these tests are very favorable. The initial current runs from 150 to 200 amperes. The maximum ranges from 65 to 95; its mean or working current 25 to 30 amperes. Its persistence is surprising. On a rheostat resistance test its iron cell battery has shown a continuous delivery of 27 amperes for a period of six hours. A severe test is to discharge the cell through an ammeter, and the time of discharge averages about one hour. Its recuperative powers are extraordinary. Commencing with a delivery of 65 amperes, after being fully discharged, it has in five minutes recovered itself completely to the starting point of 65 amperes delivery. These tests may be said to give results quite phenomenal and exceedingly gratifying to the company's manager, Mr. Ralph W. Gordon, of Boston.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
936 MONADNOCK BUILDING, CHICAGO, Nov. 11, 1893.

THE ELGIN ELECTRIC LAUNCH COMPANY, Elgin, Ill., is the name of a new concern, not incorporated, of which Frederick Sedgewick is at the head. It equips launches with electric motors, varying in power from one-fourth to four horse power, and furnishes motors for other purposes.

THE RAILWAY EQUIPMENT COMPANY, Chicago, realizing the necessity of providing an economical and practical rail bond, one which would provide an absolutely perfect connection, doing away with the possibility of corrosion, oxidation or electrolysis, in fact making such a solid joint that no air or moisture could possibly enter to destroy the connection, has lately brought out a new rail bond spring bushing, which bids fair to become standard in the trade. The bushing is a steel tube and measures one thirty-second inch larger than the hole in the rail; an opening in the bushing measures just one thirty-second. When the bushing is put on the wire and driven in, the opening closes tightly and results in making practically one piece of the rail, bushing and wire. As a needed addition to the equipment of electric roads, this device is worthy of investigation.

OREGON CITY, Ore., Nov. 6, 1893.

SOUTH BEND, WASH., voted against bonding the city to purchase the local electric lighting system.

FRANK WATERHOUSE, of the Waterhouse & Gamble Co., visited Portland, Ore., recently on his way to California.

MR. SIDNEY Z. MITCHELL, district manager of the Northwest General Electric Company, with headquarters in Portland, Ore., was married to Miss Alice P. Bell, of that city, Oct. 25. After a reception, Mr. and Mrs. Mitchell departed for Chicago and the Eastern States.

THE NORTHWEST GENERAL ELECTRIC COMPANY, through its Seattle district agency, has closed a contract with Peter Wingren, of La Conner, Wash., for a central station plant, which is now being installed. The equipment includes two 300-light incandescent machines and one 30-light arc dynamo.

CHIEF ELECTRICIAN W. C. CHENEY, of the Portland General Electric Company, has returned to his home in Oregon City after a prolonged stay in the East looking after the company's special three-phase machinery now being constructed for the new electric station in Oregon City by the General Electric Company.

THE OAKLAND CONSOLIDATED STREET RAILROAD, of Oakland, Cal., has inaugurated a novel contest for the benefit of its patrons. Every person riding will be given a ticket, and the person turning over the greatest number of tickets at the end of two months will receive the first prize. By this plan $200 will be returned to the passengers by the company every two months.

IT IS REPORTED that negotiations have been pending for some time between the three principal street railway systems of Portland, Ore., looking toward a consolidation of their interests. The lines involved comprise over 100 miles of trackage. It is estimated that possibly $50,000 yearly could be saved in operating expenses by the proposed consolidation.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, of Pittsburgh, recently located a district office at 805 Chamber of Commerce Building, in Portland, Ore. Mr. R. L. Warner is in charge as district agent. This agency recently closed a contract with the Portland Consolidated Street Railway Company for six 25-h. p. double car equipments, with "type G" controllers.

THE PORTLAND GENERAL ELECTRIC COMPANY is making great efforts to complete the new water power station at Oregon City at the earliest possible date, in order to relieve the pressure upon the present electric station. The work has been greatly hindered by a sudden rise of the Willamette River, which submerged the cofferdam, but everything possible will be done to complete the station by the time the machines arrive, of which two are now completed. There will be 20 alternating dynamos, all of them being three-phase machines of a special type.

THE CITY OF PORTLAND, ORE., was shocked on the morning of Nov. 1 by the news that an electric car on the East Side Railway Company's Oregon City line had plunged through an open draw in the Madison street bridge, in Portland, and seven persons had been drowned. The car "Inez," in charge of Motorman E. F. Terry and Conductor W. F. Powers, bound for Portland, arrived on the bridge about 7:45 a. m., the weather being foggy, with much frost on the rail. The motorman said that he had switched off the current at a distance of four spans of the bridge from the draw and reversed at one span, but the brakes failed to hold the car, which rapidly advanced with the wheels sliding and current reversed. When the red light indicating the open draw was seen, and it was found that the car could not be checked, the conductor warned the 15 or 20 passengers to save themselves, and nearly all jumped to the bridge with the conductor. The motorman clung to the remains of the frail iron gates as the car, unchecked by this frail barrier, plunged into the Willamette River, where it sank instantly. The company has been blamed for not providing better brakes and sanding apparatus. The conductor was one of the best and most experienced on the line. The motorman was said to have been an "extra man." Both men were released upon their own recognizance.

CANADIAN NOTES.

OTTAWA, Nov. 11.

WINNIPEG.—The Winnipeg Electric Railway Company has reduced the wages of its employees 20 per cent.

LONDON, ONT.—The new electric railway has been opened successfully and amidst great enthusiasm in London West.

CHARLOTTETOWN, P. E. I.—A company from the United States is looking into the prospects of establishing an electric street railway service in this city.

BRANTFORD, ONT.—An effort is being made to secure an electric railway system to connect the town of Brantford with Selkirk, on Lake Erie, a distance of 30 miles, and the estimated cost is placed at $200,000.

OTTAWA, ONT.—Notice is given that supplementary letters patent have been issued bearing the date Oct. 13, whereby the total capital stock of The Citizens' Light and Power Company (Limited) is increased from $100,000 to $200,000.

LETHBRIDGE, N. W. T.—Norman Ross, of the Canadian General Electric Company, has just installed a 500-light plant at Lethbridge and has been looking over the ground at Edmonton with a view to putting in an electric railway in that town.

SELKIRK, MAN.—The electric light company has the new power house about completed and expects to operate at once. Its new machinery is very powerful, and it will be able to supply part of the electricity for the running of the electric railway between Selkirk and Winnipeg.

HAMILTON, ONT.—The street railway company is trying a new fender. It is composed of a number of forks which run down the front of the car and turn along the ground about four or five inches from the road. Each fork has a ball point of some soft material, and it is set with a spring which allows it a certain amount of play to break the force of the impact.

REGINA, N. W. T.—The Bank of Montreal, as assignee of the Polson Iron Works Company, has sued the electric light company on a lien order or contract for sale, to recover possession of a steam engine and other articles of machinery or their value. The electric light company did not defend, but Spring Rice intervened and was used as a defendant, he claiming the machinery sued for as mortgagee of the electric light company, disputing the plaintiff's ownership of the articles.

FREDERICKTON, N. B.—Chas. A. Palmer, Q. C., solicitor for a creditor, has presented Judge Palmer an application to put the Consolidated Electric Company into liquidation. Wm. Pugsley, Q. C., has obtained a summons calling upon the applicant to show cause why the notice should not be set aside, upon the ground that the court had no jurisdiction to make an order for the winding up of the company under the Winding Up act by reason of its being a railway company and exempted from the operation of the statute. The judge ordered the summons set down for argument.

EDMONTON, N. W. T.—Norman Ross, a practical electrician of Toronto, is in Edmonton in the interests of the Canadian General Electric Company, to converse with the promoters of the electric railway. He estimates that the roadbed, including ties and rails, could be laid for $6,000 a mile; poles $500 a mile; engine, dynamo, trolley, feeder wires, motor car and two motors, $27,000, or a total of $59,000. These estimates were based upon the situation as laid before him, and not from actually going over the ground. If the company decides upon going on with the work he would make a survey and give them actual estimates. The proposed track will be standard gauge, and the power sufficiently strong to haul a Canadian Pacific Railway car up a 2½ per cent. grade. The cost of operating the line is estimated at $278 per month. The service given would be one car running six hours per day.

MONTREAL.—The Minister of Customs has notified the Auer Light Company of Montreal of the adjustment of its case without penalty, the investigation having shown an absence of fraudulent intent on the part of the manager. It appears that the manager agreed to pay $25 per quart for the fluid patented by Dr. Auer, of Vienna, with the understanding that when the company was formed in Montreal it should have the right to manufacture the fluid for itself. However, Dr. Auer, having gone back on his agreement, the company had to continue to import the fluid and pay him $25 a quart for it. The manager estimated that $7.50 was the fair market value, the balance representing the inventor's royalty, and entered it in the customs at that price accordingly; and the chemical appraiser of the customs in Montreal is said to have found by analysis that the fluid does not cost over $2 or $3 per quart to manufacture. Had the seizure turned out otherwise the company stood to lose $30,000 in fine and penalty.

BELLEVILLE, ONT.—This city is talking electric street railway. The mayor has laid the following offer from the secretary of the Canadian General Electric Company before the City Council: "In reply to a communication received from your Chairman of Industries, I beg, on behalf of, and for the Canadian General Electric Company, to apply for the necessary franchise to enable them to build and equip an electric railway in your city, and herewith submit for your consideration a copy of the agreement between the city of Kingston and the Kingston Street Railway, my clients being willing to build and equip a road under a similar agreement, so far as the terms and conditions are applicable. I should be very glad if you would refer this matter to a committee with whom I may confer as to terms, etc,, and who could prepare and report a by-law, should we be able to agree upon the terms."

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, Nov. 1, 1893.

CITY AND GUILDS OF LONDON INSTITUTE.—The annual report of the examinations department of the City and Guilds of London Institute has been issued. It shows a considerable development in the work of this important institution. The numbers of students in the classes has increased to 22,621, as against 2,500 in 1881, while the number of candidates who presented themselves for examination has increased from 895 to 10,254 during the same period. Owing to the development of the Technical Education Department of County Councils, this institute has withdrawn its money grants from classes held outside the metropolitan area, although it still registers these classes and examines them. Nothwithstanding this action the number of such classes has decidedly increased.

TAUNTON.—Dr. Fleming's report to the Electric Light Committee recommends that the present station be continued to be used, but that some important alterations and additions should be made. At present there is no reserved boiler power, so that extensions are impossible. He recommends an additional 100 h. p. for the street lighting plant, and it is proposed to put in one of Davey, Paxman & Co.'s economic boilers, at a cost of £435. Dr. Fleming also recommends that the cables be placed underground, transformer sub-stations being placed in various parts of the town.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—The winter session commences Thursday, Nov. 9, with a paper by Prof. Geo. Forbes on "The Electrical Distribution of Power."

THE PHYSICAL SOCIETY.—At a recent meeting of the Physical Society a paper was read by Mr. E. C. Rimington, in which it was shown that under certain conditions the closing of the secondary circuit of a transformer would increase the impedance of the primary circuit. It appears that this effect has been experimentally observed by more than one authority.

News of the Week.

ELECTRIC LIGHT AND POWER.

CHATSWORTH, ILL.—An electric lighting plant is projected.

ST. CHARLES, MO., is considering the question of electric lights.

LIBERTY, SULLIVAN CO., N. Y., will establish an electric light plant.

FAIRMOUNT, MINN., has voted $20,000 for a municipal electric lighting plant.

VILLISCA, IA., will vote on the question of granting an electric lighting franchise.

HILLSDALE, MICH., has purchased the local electric plant from its private owner.

FOX LAKE, WIS.—Residents contemplate an electric lighting plant and estimates are wanted.

LANARK, ILL.—The city of Lanark is figuring on securing an electric lighting plant.

EDDYVILLE, IA.—Oskaloosa parties are seeking to organize an electric lighting system at Eddyville.

JAMESTOWN, N. Y.—Mayor Price states that the electric lighting plant is in bad condition and needs overhauling.

BRACEBRIDGE, ONT., CANADA, has voted to issue bonds to amount of $25,000 for a water-works and electric lighting plant.

CAPE GIRARDEAU, MO.—Proposals are wanted to Dec. 4 for furnishing 20 arc lights for 20 years. G. E. Chalepp is City Clerk.

GEORGETOWN, TEX.—An electric lighting plant and 10 miles of wire will be purchased by the San Gabriel Water Company.

SOUTHPORT, FAIRFIELD COUNTY, CONN., is to have an electric lighting plant within 30 days of the establishment of a fire district.

NEOSHO, MO.—The Council of Neosho has appointed a committee to inquire into the cost of constructing an electric lighting plant.

WATERTOWN, MASS.—Prominent business men are getting together and will likely move to establish a municipal electric lighting plant.

ROCK FALLS, ILL., is agitating the matter of electric lighting and sewers, and authority has been granted to issue $12,000 bonds for that purpose.

RICHMOND, IND.—Proposals are wanted to Feb. 3 for lighting the streets by electricity. W. A. Dunham, Chairman Gas and Light Committee.

GRIFFIN, GA.—The general sentiment seems to be favorable to the proposed issue of bonds to the amount of $16,000 for electric lighting and water-works plant which is to be voted on Dec. 6.

STERLING, KAN.—The recent destruction of the electric lighting plant and the offer of Colonel Rocksecker to locate a plant here have caused citizens to discuss the feasibility of a municipal plant.

TREMONT, ILL.—At a special meeting of the town board Mr. Seibert, of Pekin, asked for a franchise for an electric light plant. The matter was referred to a special committee to refer to the city attorney.

CANONSBURG, PA.—Over $9,000 of the $10,000 required for the proposed electric light company has been subscribed, and it is now certain that a plant will be erected by a stock company.

GROSSE POINT, MICH.—The Grosse Point Water Company, have increased their capital stock to $100,000 and amended their articles of association so that the corporation can operate an electrical plant in connection with their water-works system.

M'SHERRYTOWN, PA.—At a meeting of Town Council, the burgess and secretary were authorized to make a contract with the Hanover Electric Light and Power Company for the introduction of electric lights into McSherrytown for a period of three years.

CONWAY, MASS.—A number of capitalists from Boston and Greenfield are looking up the matter of a water power privilege here, and they propose in connection to furnish electric

light and also power for an electrical railroad. No definite steps have yet been taken.

AMBLER, PA.—It was decided at a meeting of taxpayers that it was expedient that the borough should erect a plant and furnish their own electric lighting, but before doing so it will be necessary to have this matter settled by vote.

NORTHAMPTON, MASS.—The electric light directors have voted to erect their new plant at once. It is expected that the improvements will cost $30,000. The capacity of the new electric station will be 200 arc and 4,000 incandescent lights. Two 750-h. p. compound condensing engines will be installed.

ANN ARBOR, MICH.—Sealed proposals will be received at the city clerk's office until Dec. 1 for lighting the streets of the city of Ann Arbor with 85 arc lights of 2,000 c. p., to run from sundown to 12:30 a. m. on Philadelphia moonlight schedule; contract to run for one year. W. J. Miller is city clerk.

CROTON FALLS, N. Y.—There is much talk over a proposition to light the streets and houses by electricity, to be furnished from the dynamo in the Jungst factory, owned by George Jungst & Sons. If arrangements can be made, they propose also to extend the system to Ridgefield, Mount Kisco and other nearby towns.

EAST HARTFORD, CONN.—At a meeting held in Wells Hall it was decided to form a company, with a capital of $10,000, for furnishing electricity for light and power. P. S. Bryant, Arthur C. Liebert, John A. Stroughton and Arthur P. Moore are the incorporators, and they have a charter granted them by the General Assembly of 1893.

BOSTON, MASS.—Sealed proposals will be received to 4 p. m. Dec. 5 for electroliers, electric wall fixtures, etc., for the new public library building on Copley Square, as per specifications and plans at the office of McKim, Mead & White, at the library after Nov. 10. McKim, Mead & White have an office at 1 West Twentieth street, New York. Samuel A. B. Abbott is president of the trustees of the public library.

MADISONVILLE, O.—Sealed proposals will be received by the water-works and electric light trustees of Madisonville at their office in the town hall to Nov. 18 for the necessary dynamos, boilers, engines, etc., for a complete electric light plant as per plans and specifications on file in the water-works pumping station at Madisonville, O., or at the office of the clerk of the trustees, southeast corner Fifth and Walnut streets, Cincinnati, O. Jas. L. Megrue is clerk of trustees

THE ELECTRIC RAILWAY.

NEW BRITAIN, CONN.—The tramway company officials are asking for right of way through the streets of Plainville.

SCHUYLERVILLE, N. Y.—Surveyors have completed survey for the proposed electric road from here to Greenwich, by way of Middle Falls and Clark's Mills.

CLINTON, MASS.—The directors of the Clinton Street Railway Company have decided to apply at once for a franchise to extend the line through Lancaster.

TIVERTON, MASS.—The Fall River & Stone Bridge Electric Railway has been granted right of way for its proposed electric railway through the streets here.

NEW PALTZ, N. Y.—It is stated that B. Van Steen has sold the bonds for the proposed Highland-New Paltz Railway, and that work on the road will at once be commenced.

PROVINCETOWN, MASS.—The representative of an electric company has been here conferring with prominent business men in the matter of establishing a plant for a street railway.

FOREST CITY, SUSQUEHANNA CO., PA.—A charter has been granted to the Forest City Passenger Railway Company, $150,000, to build a railway from here to Carbondale.

TAUNTON, MASS.—The committee on streets and bridges has reported favorably on the petition of the Taunton Street Railway Company for leave to use electricity as a motive power.

WALLINGFORD, CONN.—Selectmen have approved of plans and specifications for the proposed electric road through here and they will forward same to C. L. Rockwell, of Meriden, Conn., the secretary.

CINCINNATI, O.—The Cincinnati, Hamilton & Dayton Railroad proposes to get right to use the tracks of the Cincinnati Street Railway and run an electric line from here to Hamilton. Wm. M. Green, general manager, Caren Building, Cincinnati, O.

NORWALK, CONN.—Civil Engineer Albert Hill has begun survey on West avenue and Wall street for a layout of the double tracks for the Norwalk Horse Railroad Company, to be laid in the spring, when the company proposes to equip the road with electricity.

HOOSICK FALLS, N. Y.—Ground has been broken for the proposed new electric road to connect North Hoosick and Waloomsac. W. H. Kendall, of Worcester, Mass., is in charge of construction. It is claimed that the road will soon be extended to Bennington, Vt.

RANDALLSTOWN, BALTIMORE CO., MD.—A committee is soliciting subscriptions for an electric railway to connect at Randallstown with one of the Baltimore electric lines. Harry M. Benzinger, Robert B. Chapman, George E. Lynch, Wm. E. George, R. P. Choate are interested.

LOCKPORT, N. Y.—The Lock City Electric Railway Company has asked for an extension of time to May 1, 1894, for completing its line. It has already expended $30,000. A committee was appointed by City Council to report progress and ask for time to consider.

HARRISBURG, PA.—It was proposed to sell out the South Mountain Railroad by sheriff sale, the contractor, Jas. March, having bought in the road two years ago, and being unable to meet obligations, but it is now stated that the sale has been postponed to Nov. 24, because Philadelphia capital has been enlisted. The names of the alleged backers have not been made public.

MARLBORO, MASS.—Ex-Mayor Howe states that the chances of the street railway being extended to Hudson this winter are about even. It would cost $50,000, which must be raised without increasing the capital stock. The street railway company is now making arrangements to transfer the power station of the road from the Boyd Corey Factory to the carhouse on Maple street. A new boiler, dynamo and other appurtenances will soon be placed in position.

THE SOUTH MOUNTAIN ELECTRIC RAILWAY AND LIGHT AND POWER COMPANY, Boonsborough, Md., proposes to haul Baltimore & Ohio Railroad freight cars from Keedysville to Boonsborough, Md., a distance of three miles. The road will be 4 feet 8½ inch gauge, with an 80-pound T-rail, steam road construction, eliminating grades and heavy curves. The officers are Geo. W. Jacobs, president, Philadelphia, Pa.; Chas. H. Young, vice-president, Boonsborough, Md.; Geo. W. Davis, secretary, Boonsborough, Md.; C. E. Schafer, treasurer, Boonsborough, Md., with T. E. Bowne, New York City; Elmer Smith and Edgar L. Miller, both of Frederick, Md., a board of directors. No stock except necessary shares to form company.

LEGAL NOTES.

POWER OF ONE CORPORATION TO AID OTHER CORPORATIONS.—An improvement company which was organized to buy and sell lands, erect, sell and lease buildings, to grade and improve streets, to furnish gas, electric light and water-works, to construct and operate street railways, furnaces and mills, and to acquire by purchase or subscription the stock or bonds of any mining company or manufacturing, water, gas, street railway or other improvement company, has power to give part of its stock to a railway company in order to enable the latter to complete its line to the property of the improvement company. (McGeorge v. Big Stone Gap Imp. Co., Circuit Court, W. D. Va., 57 Fed. Rep., 263.)

ELECTRICAL INSURANCE.—A legal battle of interest to the electrical fraternity has just been decided by the U. S. Court at Hartford. H. Ward Leonard & Co., of New York, wired a theatre at Middletown, Conn., for the Middlesex Mutual Insurance Company, who owned the building. The wiring was connected with the local central station. One Sunday evening, after the work was completed, and before it had been fully paid for, a fire broke out in the building and did damage to the extent of some $40,000. The property was insured, and in paying the loss the various insurance companies, six in number, took subrogation contracts enabling them to sue any party they might consider responsible for the fire. H. Ward Leonard & Co., after repeated demands for the money due them, finally brought suit for the balance due, some $3,800. This was met by a cross bill from the insurance companies, suing H. Ward Leonard & Co. for $40,000 damages, claiming that they caused the fire by negligence and improper construction. H. Ward Leonard & Co., feeling confident of their position, pressed their suit, and after various delays the case was heard before Judge Townsend. The result was a complete vindication for the company, who recovered the full amount of their claim with interest and cost.

INJURY TO MOTORMAN BY "BUCKING CARS" ON ELECTRIC RAILWAY.—In an action to recover damages for a death alleged to have been caused by negligence, it appeared that the deceased was employed as a motorman on one of the cars of an electric street railway company, and the accident was occasioned by the bucking of the car, suddenly coming to a halt and as suddenly starting up, which threw the deceased over the dashboard to the ground in front, and the car quickly ran over and killed him. The negligence charged is that the bucking of the car was caused by its defective condition, of which the company had previous notice, and yet failed to exercise reasonable care to remedy the defect, but continued to use the car, notwithstanding its known defective and dangerous condition. The evidence abundantly justified the jury in finding that the company was guilty of negligence in causing this car to be used. It had frequently bucked before, a fact well known to those to whom it had intrusted its primary duty of seeing to the condition of its cars. There was also ample evidence to warrant the jury in finding that this bucking was caused by the old and worn out condition of one of the fields, and that, through either the negligence or ignorance of those whom it had placed in charge of this department of its business, or through its own neglect to furnish them with proper instrumentalities for that purpose, no proper tests had been applied to ascertain the condition of these fields, and no proper care had been exercised in renewing or replacing such as had been worn out. The company was also bound to know that with a low dasher in front the almost inevitable result of bucking would be to hurl the motorman upon the ground in front of the car and thus to greatly imperil his life. (Beardsley v. Minneapolis Street Railway Company, Supreme Court of Minneapolis, 56 N. W. Rep., 176.)

PERSONAL NOTES.

PROF. EDWIN J. HOUSTON delivered an address before Lehigh University on the occasion of founder's day.

MR. CHARLES F. BRUSH is one of the subjects in the volume dealing with inventors in the Scribner series of books on "Men of Achievements."

MR. J. C. UPHAM, electrician for the Commercial Cable Company at its main Atlantic cable station, Canso, Nova Scotia, died on the 2d instant after a short illness, aged 55. Mr. Upham was born at Castine, Me., and was actively engaged in telegraph, telephone and cable work for 37 years. He was connected with the Western Union Telegraph Company, the New England Telephone and Telgraph Company, and was one of the early associates of the late Mr. J. B. Stearns, and probably did more to introduce and perfect duplex cable working than any other man in America. For the last 10 years of his life he was in the service of the Commercial Cable Company and by his decease that company is deprived of a valuable employe. He was a man of high integrity and sterling qualities of heart and mind and possessed exceptional ability and sound judgment and was greatly esteemed in all branches of the electrical profession.

MISCELLANEOUS NOTES.

THE AUGUSTA (GA.) EXPOSITION, which opened Nov. 14, contains a number of electrical features. It will continue to Dec. 14.

THE PENNSYLVANIA LEGISLATURE at its recent session passed a new corporation act, which, it is now learned, prevents the incorporation of electric light companies.

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS will hold its first annual meeting on Nov. 16 in the rooms of the American Society of Mechanical Engineers, 12 West Thirty-first street, New York.

CHEAP TELEPHONES IN CANADA.—The Bell Telephone Company, of Montreal, supplies telephone service for $25 a year to residents and $40 per year to business houses. It has an underground conduit system, and pays the city five per cent. of its gross profits.

HOMEMADE DYNAMOS AND MOTORS.—Mr. Geo. Dunton, of Augusta, Me., in his spare moments, has made a 20-volt 60-ampere incandescent dynamo, a motor for running an electroplater's planer and an alarm system, all of which are in practical use in his publishing house.

THE TWIN CITY ELECTRICAL ENGINEERS' SOCIETY has been organized at Minneapolis and St. Paul, Minn., with Mr. Geo. Lintner, of Minneapolis, as president and J. H. Dean, of St. Paul, as secretary. At its first meeting, on Nov. 2, Mr. Henry A. Stuckey, of Minneapolis, read an interesting paper on the prevention of fires.

THE SILVEY STORAGE BATTERY TRACTION SYSTEM is being tested on the City Street Railway, of Dayton, O., with satisfactory results. There are 100 cells to a car, each weighing 27 pounds. The car motor weighs 1,350 pounds, and is geared to both axles; it is of a new type, made entirely of steel, and will, it is claimed, develop 40 h. p. The car ran nearly nine miles in 40 minutes.

THE CONTO LAMP CASE, which came up before Judge Seaman at Milwaukee and was decided by him in favor of the Edison interests, was heard at Milwaukee on appeal on Nov. 11 and 13. A strong effort was made by the opposing interests to have the decision reversed, while the Edison attorneys were equally zealous in persuading the Court to sustain the decision. The outcome is awaited with great interest.

ELECTRIC LIGHTS AND LUNATICS.—When the current was turned on the circuits at the Long View Insane Asylum, at Cincinnati, O., for the first time, the insane patients were much affected. They tossed their hands about, fell into each other's embrace, danced with glee, and displayed an exaltation such as irrational animals sometimes do when stirred by emotional music. Improvement in many of the patients has been noted, due to the buoyant effect on the system of the surprise.

AN ELECTRICAL COLLEGE has been established in Pittsburgh under the name of the Keystone Electrical College. Such an institution was greatly needed in a city where electricity has such a great development. Its intention is to form electrical engineers and practical men to set up and run electric plants. A very interesting lecture will be given on Tuesday, Nov. 21, by Monsieur Leon le Pontois, of the Westinghouse company, on the following subject: What we know at the present time about the real nature of electricity and magnetism.

AN ELECTRICAL FIRE ENGINE.—Mr. Frank Irving, of the Franklin Electric Company, Passaic, N. J., is at work on a model of an electrical fire engine. He claims that it is practicable to build an engine which will propel itself over the streets to the scene of a fire and there work the pumps. His idea is to substitute a storage battery for the furnace and boiler now in use on steam fire engines. The Franklin storage battery is to be used, patented by Mr. Irving, and recently described in our columns. Mr. Irving feels fully satisfied that with a battery of less bulk and no more weight than the boiler and furnace now in use on steamers he can store away enough electric energy to drive an engine two miles over any streets fit for wagon use and to run the pumps steadily for six hours afterwards.

THREE MUNICIPAL PLANTS.—Mayor Price, of St. Joseph, Mo., says that their plant has been in use five years and is satisfactory in every way. The first cost of it was $56,000, but enough has since been added to bring it up to $96,000. There are 324 arcs, burned on a moonlight schedule, and the cost of each light is $81.96 per year. In Olyphant, Pa., the electric plant is controlled by the borough, and furnishes light to private consumers at actual cost, which is said to be one-half the price charged in other places where the plant is owned by individuals or corporations. In Jamestown, N. Y., Mayor Price recently said that the municipal electric light service was most unsatisfactory; he stated that Alderman O'Connoll's brother, who is the engineer of the city electric light plant, has been ill, and that a young man has been in charge in his stead. An alderman has the statement of an engineer that it is not safe to remain in the building when the machinery is in operation, and the builder of the engine in the works has stated that unless immediate attention is given to the machinery it will soon be fit for the scrap heap.

ELECTRIC ADVERTISING.—Mr. J. McFarlan Moore read a paper entitled "Electricity in Advertising" before the last meeting of the New York Electrical Society, in which he enumerated at length the various manners in which electricity has been employed for this purpose. To Mr. W. J. Hammer is ascribed the honor of having originated electrical spectacular and advertising effects, some of which, such as the great lamp at the Cincinnati Exhibition of 1888 and the Edison decorations at the Paris Exposition of 1889, still remain unequaled. The electric sign, 60 by 68 feet, at the south end of Madison Square has 107 letters, averaging six feet in height, and contains 1,457 lamps, representing 145 h. p. and costing 24 cents per minute for current alone. Mr. Moore explained a plan of electrical advertising, of which he is joint inventor, consisting in covering a vertical surface with small electric lamps arranged closely together; each lamp is controlled by a button on an operating board, having the same relative position as the lamp. By this means writing or any desired design may be reproduced in letters of fire, either by means of a stencil or by simply performing the operation of writing or drawing on the operating board.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The eighty-first meeting of the Institute will be held at headquarters, 12 West Thirty-first street, New York City, on Wednesday, Nov. 15, at 8 o'clock p. m. The business of the evening will be the discussion of the report of the special committee of the Council appointed at the last meeting, on local meetings of the Institute. The November number of the Transactions will not be issud until the November meeting. By instructions of Council it will contain the names of candidates for associate membership to be acted upon at the meeting of Council, Dec. 20, as follows: E. L. Etheridge, Chas. T. Lindner, Frank A. Williams, D. McFarlan Moore, Arthur N. Mansfield, Chas. L. Sturtevant, Wm. L. Puffer, Louis K. Comstock, Herbert S. Mustin, Harold P. Brown, Charles H. Warner, W. A. McClurg, O. R. Roberson, Leonard C. Wason, Dr. Johann Sahulka, W. Le Conte Stevens, Daniel W. Shea, C. R. McCay, Mario Capriccio, John E. Hudson, Henry J. Sage, Wm. B. Martin, Francis R. Frost, A. A. Serva, A. Marcel Requier, Chas. L. Jaeger, Geo. W. Redfield, Fred. B. Corey, Jas. W. McCrosky and Elbert F. Norton. Any member objecting to the election of any of these applicants should notify the secrtary to that effect prior to Dec. 20.

Trade and Industrial Notes.

JOHN B. WHALEN & CO., Sycamore, Ill., manufacturers of electrical supplies, are erecting a large factory.

THE BELKNAP MOTOR COMPANY, Portland, Me., has recently installed a 250-light dynamo for the Bath Iron Works.

GEORGE CUTTER, The Rookery, Chicago, is now carrying, or at least trying to carry, some of the Waterhouse incandescent arc lamps in stock, so as to fill Western orders more rapidly.

THE STANDARD ELECTRIC TIME COMPANY, New Haven, Conn., is now placing one of its electric striking clocks, which we illustrate elsewhere, in the tower of the Waterbury Clock Company's new building at Waterbury, Conn.

THE ARNOUX HOCHHAUSEN ELECTRIC COMPANY, 478 Pearl street, New York, has issued a circular calling attention to the advantages of their Boissier's direct reading volt and ampere meters to manufacturers, and especially electroplaters.

THE UNIVERSAL ELECTRIC PULL SOCKET AND SWITCH COMPANY, 27 Beaver street, New York, has equipped the Hotel Savoy with the Universal pull sockets and switches, and, according to the statement of the man in charge of lighting and extinguishing, it takes just one-tenth the time that it did with former appliances.

THE CENTRAL ELECTRIC COMPANY, of Chicago, Ill., is having great success with its high grade porcelain insulators, which are rapidly displacing the many cheap and inefficient insulators now in the market. Their new key socket has also met with great favor, and among the number of flattering letters received they quote the following: "After examining the socket I would say that it seems to be up to the standard in all particulars. The contacts are good and the weight and breadth somewhat greater than other styles. In fact, we rather like the looks of it, and you may ship your socket in place of the one ordered."

THE RELIANCE GAUGE COMPANY, Cleveland, O., have had their Reliance safety water columns adopted by the manufacturers of the Stirling and the Climax boilers, for exclusive use on these boilers in the future. Their adoption only took place after the columns had been used on these boilers during about five months of the World's Fair, where they carried off the highest and only award. The Stirling company recently placed an order with the Reliance Gauge Company, Cleveland, O., for 100 No. 7 Reliance columns, and the Clonbrock Steam Boiler Works, Brooklyn, N. Y., began using columns of 18 inches and 24 inches on all Climax boilers made by them in September.

THE ALEXANDER-CHAMBERLAIN ELECTRIC COMPANY, 136 Liberty street, New York, has installed a handsome electrical show piece in a window of the store of I. L. Burnett, on 75th street and Columbus avenue, New York.- It consists of a complete model of the Ferris wheel There are 16 spokes on the wheel, and at the end of each is placed a 16 c. p. electric lamp of different colors. The wires from the lamps are led to the hub, on which the safety fuses are placed, and from these fuses two wires lead out through the shaft to the collector rings, placed at the edge, on which two brushes connect with the isolated plant in the building. Revolution is effected by means of a small electric motor and a series of belts, the speed of which can be changed by a variable resistance in the motor circuit.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., have received a contract from the Turner & Seymour Manufacturing Company, Torrington, Conn., to furnish all of the ironwork for their new foundry building. The old foundry was burned a short time ago, and the company has determined to build their new foundry entirely of iron and brick, the side walls being of brick, the roof of iron. The roof will be furnished by the Berlin Iron Bridge Company, of East Berlin, Conn., and will consist of iron trusses and iron purlins covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron. When completed, the building will contain no woodwork whatever except the window frames and casings, so that it will be absolutely fireproof, and it is the intention of the Turner & Seymour Manufacturing Company to carry no insurance on the building, as the Berlin company guarantee that, if all the wooden flasks which the company use at any one time were piled in one place in the building and fired, the roof would suffer no damage.

THE W. S. HILL ELECTRIC COMPANY, of Boston, Mass., is rapidly coming to the front as a manufacturer of high grade switchboards and switches. We understand that during the general depression of the last few months it has been pushed to its utmost capacity to fill orders, running nights a portion of the time, which speaks volumes for it. Besides the 50-circuit arc switchboard, recently constructed by the W. S. Hill Electric Company, Boston, Mass., for the Narragansett Electric Lighting Company, of Providence, R. I., which we illustrate elsewhere, it has completed several others, among them one similar to the one illustrated for the Lynn Gas and Electric Company, of Lynn, Mass., for 24 circuits, and we understand it is now at work on an eight-panel alternating switchboard to take care of six 7,000 light machines, and has several more under consideration. Its very large and complete line of switches is unexcelled and its business in this direction has assumed rapidly increasing proportions. We are informed that it recently shipped on one order switches aggregating over three and one-half tons in weight, and comprising some of 1,000 and 4,000 amperes capacity, the latter we believe to be one of, if not the largest ever made in this country. A large number of finished parts for switchboards and switches is kept constantly on hand, ready to assemble at a moment's notice, thus insuring prompt delivery. The company is represented in New York by the Elson & Brewster Engineering Company, 122 Liberty street.

LA ROCHE ELECTRIC WORKS.—The constantly growing demand for larger units in electrical work, and the success with which the La Roche company has met in the installation of its alternating and direct current apparatus during the past year, has necessitated a very large enlargement and extension of its factory and office facilities in order to handle comfortably the increasing business. The president and general manager of the company, Mr. F. A. La Roche, so well known to the electrical fraternity, is kept very busy watching its numerous interests, for even through the extremely dull summer season the factory has been running continuously, some large orders have been taken and much prospective work has been estimated upon. Additions to the engineering force of Geo. W. Bacon, of the Wightman Electric Railway Company, and Frank R. Ford, formerly Chicago agent of the Short Electric Railway Company, have recently been made, while Geo. S. Loutey, general construction superintendent for the company, still oversees the installation and operation of the apparatus. The company is also represented by selling agencies at St. Louis, Boston, Pittsburgh, Cincinnati, Mobile, Knoxville and San Francisco, and is establishing district agencies in New York and Chicago. The new works, consisting of a spacious six-story brick building, located on the Philadelphia & Reading Railroad, at American and Diamond streets, Philadelphia, are well calculated to meet every requirement for the prompt handling of the large alternators and generators which are now being built, for while having added advantages of the best and most convenient shipping facilities, there has been no expense spared in equipping the factory with the most complete and modern machinery, all of which is driven directly without the intervention of intermediate shafting from the slow speed automatic La Roche motors distributed through the factory. Many special machines have also been added to the factory equipment, by means of which the entire machine work, assembling and final testing, can be completed with practically no handling or moving of the heavy castings.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N.Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

UNITED STATES PATENTS ISSUED OCT. 31, 1893.

IN CHARGE OF W. A. ROSENBAUM, 177 TIMES BLDG., N. Y.)

507,522. ELECTRICAL STEERING GEAR; C. W. Ayton, New York, N. Y. Application filed July 13, 1892. The combination with the rudder of a boat, of electric motors engaged therewith, a mariner's compass, means for periodically tilting the needle of the compass, electric terminals in the path of the needle when in predetermined positions and an electric generator with the motors.

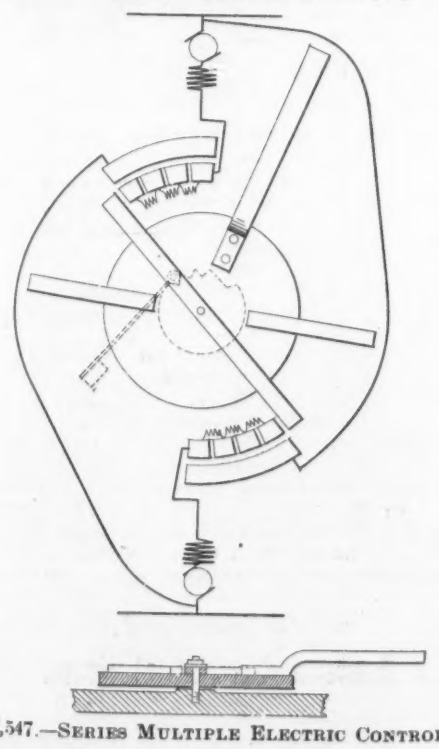
507,526. ELECTRICAL TRANSFORMER; W. P. Carstarphen, Jr., Denver, Colo. Application filed Nov. 7, 1892. The combination with an incandescent lamp circuit and socket of a transformer terminating at one end in a plug adapted to fit the socket, the construction being such that the primary coil of the transformer is directly connected with the lamp circuit by inserting the transformer in the socket.

507,539. ICE SCRAPER FOR TROLLEY WIRES; W. Heston, Alliance, O. Application filed Nov. 26, 1892. In combination with an overhead conductor, a trolley pole and trolley, of a scraper having yielding support.

507,547. SERIES MULTIPLE ELECTRIC CONTROLLER; A. P. Knight, Boston, Mass. Application filed Jan. 26, 1892. The combination with a constant potential circuit of an electric motor in series with a second motor on the circuit, a separable connection for the motor and a connection around it containing a resistance. (See illustration.)

507,554. INCANDESCENT ELECTRIC LAMP; W. E. Nickerson, Cambridge, Mass. Application filed July 31, 1893. In an incandescent electric lamp in which the neck of the lamp bulb is closed air-tight by a plug of fusible cement, leading-in wires composed of two sections of different conducting capacity, that of the lesser capacity being next the filament within the lamp and that of the greater capacity within the cement plug by which the lamp is closed air-tight.

507,555. INCANDESCENT ELECTRIC LAMP; W. E. Nickerson, Cambridge, Mass. Application filed July 31, 1893. In an air-tight incandescent lamp bulb, the combination of one or more discs having a dished form located in the neck of the lamp bulb and adapted to support the cement plug.

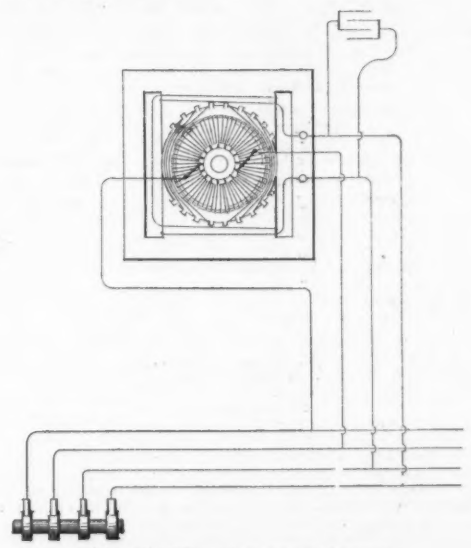


No. 507,547.—SERIES MULTIPLE ELECTRIC CONTROLLER.

507,556. INCANDESCENT LAMP; W. E. Nickerson, Cambridge, Mass. Application filed July 31, 1893. In an air-tight incandescent lamp bulb, mica discs located between the cement plug and the filament, the discs having been subjected to a high degree of heat for the purpose of increasing their capacity to intercept heat rays.

507,557. INCANDESCENT ELECTRIC LAMP; W. E. Nickerson, Cambridge, Mass. Application filed July 31, 1893. In an incandescent electric lamp in which th eheat-reflecting disc located in the neck is used to protect a plug of fusible cement, by which the lamp is closed air-tight, a bar of glass attached to the leading-in wires and adapted to hold the said heat reflecting disc in position.

507,558. INCANDESCENT ELECTRIC LAMP; W. E. Nickerson, Cambridge, Mass. Application filed Aug. 5, 1893. In an air-tight incandescent electric lamp bulb a cement plug composed of a resinous body made flexible and adhesive by fat solid at ordinary temperatures.



No. 507,658.—ELECTRIC MOTOR.

507,565. TEST AND SIGNAL CIRCUIT AND APPLIANCE; T. Spencer, Cambridge, Mass. Application filed Nov. 19, 1892. The combination of an open main circuit, a polarized signal instrument included therein; a circuit closer therefor; a battery also included therein and arranged to direct a current of electricity through the instrument, with a normally discontinuous loop of the circuit, shunting the battery and the signaling instrument, a circuit closer therefor, and a second battery of higher electromotive force included in the loop, the second battery being so arranged that upon the closure of the loop by the operations of its circuit closer, it will oppose the small battery and cause a resultant current of opposite direction to flow through the helices of the polarized signal instrument and thereby prevent the operation of the signal or reset the same if already given.

507,568. TELEPHONE CIRCUIT; J. S. Stone, Boston, Mass. Application filed Jan. 31, 1893. A telephone circuit between two stations, containing at each a variable resistance transmitter and receiving telephone; a branch or bridge uniting the direct and return conductors of the circuit at some intermediate point between the two stations; a transmitter current supplying generator included on the bridge, and two electromagnetic resistance or impedance coils also included in the bridge in multiple arc with each other and in series with the generator.

507,569. ELECTRO-PROTECTIVE SYSTEM; F. G. Storey, Cambridge; E. R. Andrews and J. P. Cushing, Boston, and H. B. Eaton, Quincy, Mass. Application filed June 24, 1893. This comprises an electric circuit provided with a signal controlling relay and test relay, a test circuit controlled by the test relay, an electromagnet on the test circuit and a circuit controller for the test circuit.

507,589. ELECTRIC CAR BRAKE; J. H. McEvoy, Waterbury, Conn. Application filed Dec. 30, 1892. The combination with the brakes of car and its axle, of connecting mechanism for the two, a worm gear interposed in this connecting mechanism, the parts of the worm gear being made separable, and an electromagnet operating to connect the parts of the worm gear.

507,606. ELECTRIC RAILWAY SUPPLY SYSTEM; G. T. Woods, New York, N. Y. Application filed March 2, 1893. In a system of electrical distribution, an electrical generator, electrical conductors in electrical connection therewith, insulating supports for the electrical conductors, a tube or pipe arranged parallel to the electrical conductors, a tubular communication between the pipe and each of the insulating supports.

507,629. SYSTEM FOR OPERATING ELECTRIC MOTORS; E. C. Morgan, Chicago, Ill. Application filed June 9, 1892. In a system for operating electric motors, the combination of a dynamo, a motor for actuating the tool, devices for shifting the current supplied to such motor and mechanism for reducing the strength of the current synchronously connected to the shifting device.

507,641. TROLLEY-WHEEL GUARD; J. N. Akarman and F. Le Noir, Worcester, Mass. Application filed April 10, 1893. This consists of a support, wires attached to the support and extending below and upon each side of the trolley wire and parallel thereto.

507,658. ELECTRIC MOTOR; J. F. Kelly and C. C. Chesney, Pittsfield, Mass. Application filed Dec. 7, 1892. The method of operating commutating motors by alternating currents, which consists in passing through the field and armature circuits, respectively, alternating currents differing in phase and proportioning and adjusting the motor circuits so as to produce a correspondence in phase. (See illustration.)

507,660. MAIL BOX; A. Krastin, Cleveland, O. Application filed Jan. 6, 1893. An automatic mail box provided with a slot and a spring actuated cover in combination with an interior spring actuated platform, and guards so arranged as to depress the platform when the cover is depressed after depositing a letter in the box.

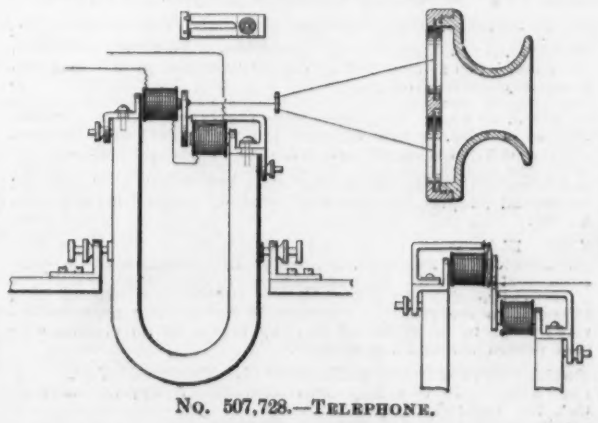
507,671. ELECTRICALLY OPERATED MACHINE FOR MOLDING CLAY OR CEMENT PIPES; R. Boeklen, Omaha, Neb. Application filed July 30, 1891. The combination with a vertically moving rammer stock, of a perforated plate having annular screw-threaded flanges and a central opening, top and bottom heads, tubes connected therewith, inner cores of soft iron, the coils located between the cores and tubes, the rammer bar and its soft iron cylinder or core and means for automatically making and breaking the circuit of the coils.

507,678. INSULATING COMPOUND; J. J. Fanning, Chicago, Ill. Application filed May 27, 1893. This consists of plaster of paris, asbestos, dextrine and linseed oil.

507,689. MAGNETIC FRAME FOR FIELD MAGNETS; A. L. Riker, New York, N. Y. Application filed July 27, 1893. A laminated field magnet frame for multipolar dynamos or motors composed of two sets of blanks or stampings, one set forming the pole pieces and the other the core sections, portions of the blanks in each section being turned in opposite directions, the pole sections having large central bolt holes, and the other bolt holes in the projecting portions of the blanks for connection with the core sections, so that each section is detachable from its adjacent sections.

507,690. LAMINATED FIELD MAGNET FRAME FOR DYNAMO-ELECTRIC MACHINES; A. L. Riker, New York, N. Y. Application filed July 27, 1893. A field magnet frame for dynamo-electric machines composed of three blanks or stampings of wrought iron, constituting, when laid together without overlapping, a symmetrical figure with the core projection at one end and the pole pieces at the other, adjacent layers or groups being reversed so as to constitute tongue and groove joints.

507,691. ELECTRIC CIRCUIT TESTING AND SWITCHING DEVICE; M. Robinson, Newton, Mass. Application filed March 6, 1893. The combination of switches, a central post, a spring opposed collar moving on the post inclosing a case, and a hinged cover engaging with the collar.



No. 507,728.—TELEPHONE.

507,694. TELEPHONE TRANSMITTER CIRCUIT AND APPARATUS; J. S. Stone, Boston, Mass. Application filed May 22, 1893. This consists of a variable resistance transmitter, a current supply circuit therefor, including in series the transmitter and primary helix of its associated induction coil, an electrostatic shunt circuit around the transmitter and primary helix, with a direct or conversation circuit, including the secondary helix of the induction coil, and a speaking telephone.

507,703. ELECTRICALLY OPERATED PIANO; L. J. Zimmerman, Linden, N. J. Application filed Sept. 16, 1892. The combination with the keys, hammer mechanism and battery of solenoid magnets, their cores, rods, links, bell crank lever and vertical rods and electric mechanism for operating the solenoidal magnets.

507,708. GALVANIC BATTERY; J. A. S. Gregg, New Rochelle, N. Y. Application filed April 3, 1890. The combination of a cell, an electrode in same, an inlet conduit to an outlet conduit from it, an independent reservoir for electrolytic liquid communicating with the inlet conduit, a frame supporting the reservoir, and means for adjusting its elevation with reference to that of the cell.

507,715. TELEPHONE TRANSMITTER; J. H. Mason, Brooklyn, N. Y. Application filed June 6, 1893. Finely divided carbon treated with wax as an electrical conductor.

507,728. TELEPHONE; S. D. Field, Stockbridge, Mass. Application filed June 30, 1893. A magneto telephone provided with an armature supported in a magnetic field, a compensating device for equalizing the strain of said armature upon a diaphragm in all positions of the armature, and a coil inductively related to the magnetic field. (See illustration.)

507,732. SWITCH FOR TROLLEY WIRES; G. A. Huben, Springfield, O. Application filed July 29, 1893. This comprises a triangularly shaped body, having a curved top and projecting flanges on opposite sides, auxiliary flanges adjacent to the main flanges to form openings, a projecting post at the junction of the auxiliary flanges, and a roller bearing on the post.

507,733. TROLLEY FOR ELECTRIC RAILWAYS; G. A. Huben, Springfield, O. Application filed July 29, 1893. An auxiliary arm pivoted to the trolley arm or pole, a curved base, a projecting post connected to the main arm or pole adapted to form a guide for the base, a curved supporting rod, projections on opposite sides of the base to support the ends of the curved rod, and springs arranged on the rod and interposed between the projecting post and supporting projections.

507,791. MACHINE TELEGRAPHY; P. B. Delany, South Orange, N. J. Application filed May 4, 1893. The combination with means for continuously drawing a ribbon to be perforated, a punch for perforating the ribbon having an inclined cutting edge or face extending from the lowest point of the punch upwardly and on the side from which the paper approaches, and means for actuating the punch.

507,803. COMBINED SWITCH AND CUT-OUT FOR ELECTROLIERS; Iczak Goldkind, Max Stirn and Louis Stirn, New York. Application filed April 25, 1893. The combination with a porcelain body of an electric cut-out on same, a piece hinged on the porcelain body, and an electric switch on the hinged piece, which switch is connected with the cut-out.

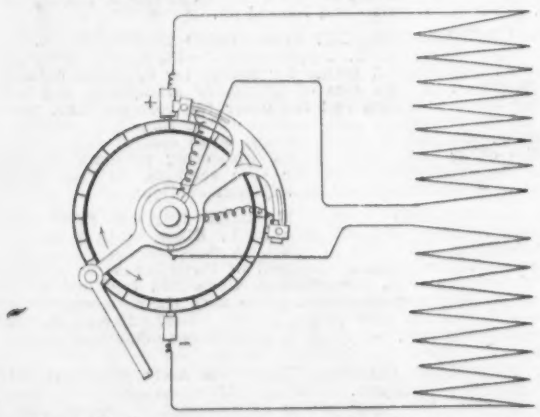
507,806. CONDUIT RAILWAY CONDUCTOR; J. W. Grantland, Philadelphia, Pa. Application filed May 17, 1892. This consists of a hollow conductor provided with a partial covering of insulating material and means for supplying a heating medium to the conductor.

507,867. ELECTRIC ARC LAMP; Henri Wilbrant, Brussels, Belgium, and Louis Sterne, London, England. Application filed July 6, 1893. This consists of an upper carbon holder, an electromagnet included in a shunt on the arc, an armature adapted to be attracted by the electromagnet and having a hole for the passage of the upper carbon holder, regulating springs for controlling the armature, a strip connected with but insulated from the armature, and a stop with which the strip is adapted to make and break contact, said strip and stop being included in the circuit whereby any break between them of contact will interrupt the current through the magnet.

507,869. ELECTRIC SIGNAL APPARATUS; J. C. A. Xiezopolski and Chas. Bode, Milwaukee, Wis. Application filed June 29, 1893. This consists of a suitable housing, metallic strips on opposite sides of the housing electrically connected, and one wire of an electric circuit, including an audible signal, contact posts projecting inwardly from opposite points on the metallic strips, a second series somewhat similar, suitable connections extending to the outside of the housing for holding the free ends of contact springs midway between the contact posts.

507,912. DEVICE FOR DEMAGNETIZING WATCHES; F. M. La Bolteaux, Cincinnati, O. Application filed Jan. 1, 1893. The combination of a base, a helix mounted thereon, having its terminus connected with a source of electricity producing an alternating current, the carriage mounted to slide on the base within the helix, the revolving carrier mounted on the carriage, and means to revolve the carrier while it is introduced within or withdrawn from the helix.

507,916. ELECTRIC ARC LAMP; W. B. Luce, Brookline, Mass. Application filed Nov. 26, 1892. This consists of a polygonal hollow column or guide rod, a sliding collar engaging the column and having an arm or extension constructed to hold the upper carbon, and a counterbalancing weight occupying the hollow column and connected with the arm or extension.



No. 507,945.—System of Electrical Transmission of Power.

507,918. ELECTRIC TRAIN AND SWITCH SIGNAL DEVICE; G. E. Miller, Saugus, Mass. Application filed May 24, 1893. This consists of insulated alternately broken conductor rails, a battery carried on the train, a ground wire connected to one pole of the battery and provided with a switch-button, an alarm or signal connected with the other pole of the battery by a wire, a wire connected to the signal and provided with a contact button, a brush or sweeper held in contact with the conductor rails, a wire connected with the brush, and a switch intermediate, the wires connected to signal and brush and adapted to make and break contact with the switch button.

507,925. ELECTRIC BURGLAR ALARM; T. S. Patty, Cooper, Ia. Application filed Jan. 26, 1893. This consists of an electromagnet fixed to the interior and bottom of a box and an armature pivotally attached to a suitable support and held adjacent to the poles of the magnet by yielding pressure devices so as to be attracted to it by means of an electric current passed through the magnet.

507,945. SYSTEM OF ELECTRICAL TRANSMISSION OF POWER; C. J. Van Depoele, Lynn, Mass. Application filed Oct. 23, 1890. The combination with the commutator of a continuous current generator or distributer of main stationary commutator brushes thereon, an arm moving radially to said brushes carried in adjustable commutator brush holders upon said extensions, and means for imparting a radial movement to the commutator brush boxes and brushes over a limited number of the commutator sections to collect currents having a maximum potential less than that between the main brushes. (See illustration.)

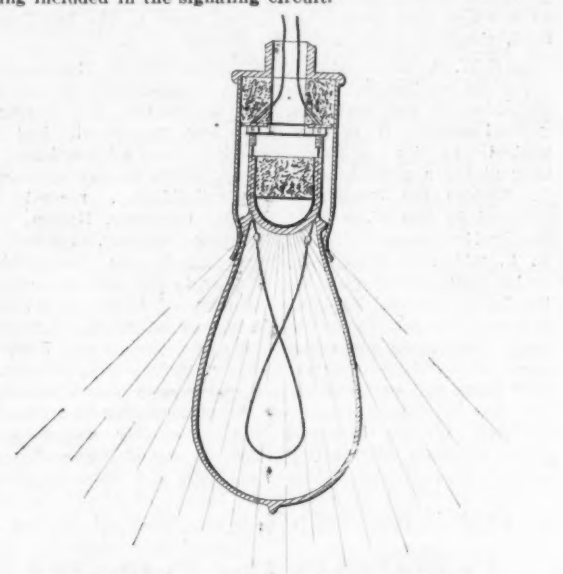
507,946. PORTABLE ELECTRIC PUMP; C. J. Van Depoele, Lynn, Mass. Application filed Feb. 26, 1891. An electric engine having motor coils actuated by currents supplied through main conductors, in combination with an intermediate conductor of different lengths, and detachable circuit connections whereby the circuit of the intermediate conductor is ruptured before opening the circuit of the main conductors.

UNITED STATES PATENTS ISSUED NOV. 7, 1893.

(IN CHARGE OF W. A. ROSENBAUM, 177 TIMES BLDG., N.Y.)

507,978. INCANDESCENT ELECTRIC LAMP; C. R. Arnold, Sharon Hill, Pa. Application filed Feb. 28, 1891. In an incandescent lamp the combination of a globe, a hollow glass stopper having the leading in wires sealed between the stopper and the neck, a reflector formed on the stopper and a filling of plaster of paris or similar material. (See illustration.)

507,983. AUTOMATIC SIGNAL FOR TRUNK LINES OF TELEPHONE EXCHANGES; O. A. Bell, Brooklyn, N. Y. Application filed Feb. 7, 1893. The combination with a trunk line of a signaling circuit including a portion of the trunk line, contact points at one end of the trunk line adapted to be separated when connection is made at that end, contact points at the other end of the trunk line adapted to be closed when connection is made to that end of the line, the contact points being included in the signaling circuit.



No. 507,973.—Incandescent Electric Lamp.

507,997. ELECTRIC LOCOMOTIVE; J. I. Conlin, Brooklyn, N. Y. Application filed Dec. 8, 1892. The combination of a driving shaft mounted in the car frame parallel to the axles, cranks on the opposite ends of the shaft, eccentric wrist-pins on the carwheels, rods connecting the cranks to the pins, a gear wheel on the shaft, a series of motors mounted in the frame around the shaft and a gear wheel on the armature shaft of each of the motors, engaging the wheel of the shaft.

508,000. ELECTRIC MOTOR APPARATUS; J. C. Davidson, Prince's Bay, N. Y. Application filed May 2, 1893. The combination of a primary series motor, a generator connected therewith, mechanism for starting the motor, and electrical connections between the motor armature and the field of the generator actuated by the lever of the switch mechanism after the motor is started, to charge the field of the generator by part of the current passing through the motor armature.

508,037. CLAMP FOR HOLDING ARTICLES WHILE BEING WELDED; A. J. Moxham, Johnstown, Pa. Application filed Feb. 2, 1892. A welding clamp consisting of two jaws adapted to embrace the piece to be welded at the welding point, said jaws being pivoted or hinged to an adjustable rod or standard.

508,050. CIRCUIT-BREAKING DEVICE FOR RECIPROCATING ELECTRIC MACHINE; C. H. Richardson, Philadelphia, Pa. Application filed July 2, 1892. The combination in a circuit breaker of a magnet and an armature, a rigid contact point carried by and insulated from the armature, a movable contact point carried by the armature, and the free or contact end of which is weighted and a movable stop by means of which the stroke of the armature may be adjusted.

508,054. MULTIPLE SWITCHBOARD SYSTEM FOR TELEPHONE EXCHANGES; C. E. Scribner, Chicago, Ill. Application filed Feb. 7, 1893. The combination with a telephone line extending from a sub-station to a central office and connected with springjacks thereat and terminating in a loop plug, of a self-retaining annunciator having its operating coil connected with the line circuit, a socket for receiving the terminal plug when out of use, a cord switch in the socket, a local circuit extending from the ground through the retaining cord of the annunciator, a battery and normally closed contacts of the cord switch and connected with contact pieces upon the springjacks, and means for closing the springjack contacts to earth when connection is made therewith, whereby the self-retaining annunciator is prevented from being operated by currents in the line when connection is made to any springjack of the line.

508,068. LIGHTNING CONDUCTOR; G. T. Walch, Kaufbeuren, Germany. Application filed Feb. 21, 1893. In a lightning conductor, the combination with a conducting wire, and a casing therefor, of a cross-shaped sleeve.

508,069. POLARITY SWITCH FOR SECONDARY BATTERY SYSTEMS; A. H. Whiting, New York, N. Y. Application filed June 1, 1893. The combination with a secondary battery circuit and connection terminals for a main or charging circuit, of a polarity switch comprising a polorized bar pivoted in a suitable support and having contacts or circuit closers at each end, each having co-operating stationary contacts and an exciting coil for the bar connected across the main line terminals.

508,083. ELECTRIC RALWAY SYSTEM; C. T. Brain, Liverpool, England. Application filed Aug. 29, 1891. In an electric railway, the combination with a slotted power conduit, of a covering device and mechanism for raising the covering device from its seat during the passage of the vehicle connector.

508,104. CONDUIT RAILWAY TROLLEY; H. A. Goreham, Decatur, Ill. Application filed Jan. 31, 1893. A trolley for underground wires comprising the vertically slotted bracket, the trolley standard in the slot of the bracket and springs connecting the standard with the bracket and tending to force the standard downward.

508,107. INSULATING COMPOUND FOR PRINTING PRESSES; H. Haynes, Philadelphia, Pa. Application filed April 20, 1893. An insulating compound for a printing press composed of machine oil, wax, glycerine and castor oil.

508,129. ELECTRIC MOTOR; W. P. Carstarphen, Jr., Denver, Colo. Application filed Nov. 18, 1892. In an electric motor the combination of the armature and field, a commutator to which the terminals of the armature coils lead, a divided contact plate with which the terminals of the field coils are connected, and a movable cap carrying brushes engaging the armature and the divided contact.

508,188. ALTERNATE CURRENT ELECTRIC MOTOR; W. Stanley, Jr., Great Barrington, Mass. Application filed Oct. 23, 1888. An electric motor having magnetizing coils designated to be connected in a source of alternating electric currents, and a supplemental coil surrounding the armature, and assisting in polarizing effects the armature coils and connected in a circuit receiving currents by induction from the first-named coils. (See illustration.)

508,199. CLOSED CONDUIT ELECTRIC RAILWAY; O. B. Benton, Cleveland, O. Application filed May 31, 1893. In an electric system, a movable contact maker, a current conveyor connected with the car, and insulated means before and behind the conveyor to depress the contact maker into circuit.

508,208. REGULATOR FOR DYNAMO-ELECTRIC MACHINES; A. M. Cullingworth, New York, N. Y. Application filed May 6, 1892. The combination of a dynamo-electric machine having a movable current collector, a magnetic body magnetically connected with the metal of the machine in the magnetic circuit for shifting the current collector, the magnetic body being arranged in proximity to the armature of the machine and adapted to vibrate under the influence of the armature.

508,214. TELEGRAPH KEY. J. R. Frank, Minneapolis, Minn. Application filed May 29, 1893. The combination with a telegraph key, of an extended contact, a self-closing switch lever pivotally suspended from the key lever at a point outside of the centre of gravity of the lever, a button at the outer end of the key lever and a cap piece having a stem working through the button and pivoted to the outer end of the switch lever, the button and cap piece having continuous coincident and unobstructed peripheral margins.

508,215. ELECTRIC TIME SIGNALING SYSTEM; J. H. Garry, Brooklyn, N. Y. Application filed Aug. 10, 1892. In a time signaling system, the combination of a main line, a series of transmitting instruments adapted to transmit prearranged signals, a series of circuit makers connected with the respective transmitters and adapted to be operated successively and means adapted to place the circuit makers simultaneously in and out of the operative position.

508,236. CONDUIT ELECTRIC RAILWAY; J. Pawolowski, Cincinnati, O. Application filed Feb. 27, 1893. The combination of an underground conduit, the line wires and trolley wires therein, the feeder connecting the main wire and trolley wire and buttons to insulate the feeders from the conduit.

508,255. TELEPHONE CIRCUIT; J. S. Stone, Boston, Mass. Application filed Jan. 31, 1893. In a telephone system, the combination of a common current generator for the transmitt- combination of a common current generator for the transmitters of the system; a number of telephone circuits of approx- erator, and a relatively high inductance device connected in series with the common generator.

508,262. ELECTRIC TOOL; G. H. Williams, New York, N. Y. Application filed Dec. 28, 1892. An electric tool having a cylindrical shell open at both ends and normally closed by removable caps, a solenoid located in the shell and secured to the lower cap, the core of the magnet comprising a tubular portion with annular plates upon both ends, the inner end of the wire under the coil secured to the upper end plate and the other end of the magnet wire passing through an opening in the shell and insulated therefrom.

508,284. ELECTRICALLY HEATED SOLDERING IRON; C. L. Coffin, Detroit, Mich. Application filed Dec. 10, 1892. In combination with a magnetic body located within the soldering head of a soldering iron, an induction apparatus.

508,295. ELECTRIC CABLE; H. W. Fisher, Pittsburgh, Pa. Application filed Aug. 7, 1893. In combination with the insulated wires of an electric cable one or more conductors having a high insulation, whereby they are protected as against an injury destructive of the insulation of the other wires of the cable.

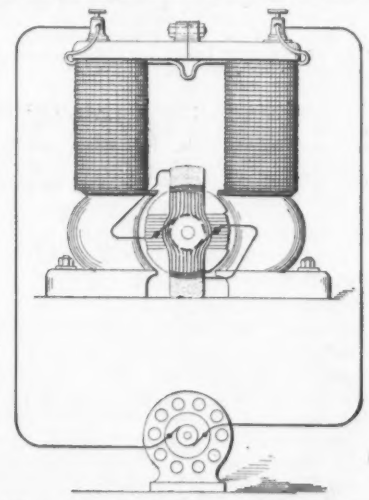
508,314. CARBON HOLDER; C. C. Hill, Newport, R. I. Application filed Jan. 18, 1893. A carbon holder for electric lamps formed of a cylindrical longitudinally slotted socket provided with thickened ends and furnished with a circumferential groove near one end, and a circular spring fitted to the circumferential groove.

508,322. ELECTRIC REGULATOR AND SWITCH; W. N Jones, Jr., Petersburgh, Va. Application filed July 20, 1893. In a regulator and switch for electric cars, the combination of two concentric rheostats, two concentric series of segmental plates leading thereto, a central shaft with insulated metal tubes bearing contact arms playing respectively upon the series of plates, the central shaft and metal tube forming two independent paths for the current centrally through the rheostats.

508,343. EXTENSION ELECTROLIER; A. Rivenburgh, Greenfield, Ia. Application filed July 27, 1893. An extension electrolier, comprising a supporting tube rectangular in cross section, longitudinal conductors in the tube, and a sliding tube fitting in the bore of the supporting tube and provided at its upper ends with springs engaging the conductors, the springs extending over the upper end of the sliding tube and extending downward in an oblique direction.

508,356. RAILROAD SIGNAL SYSTEM; G. L. Thomas, Brooklyn, N. Y. and E. C. Seward, Montclair, N. J. Application filed July 1, 1893. In combination, a rear signal and its operating mechanism, a header signal under the control of the rear signal operating mechanism to return it, and independent mechanism for releasing and returning the header signal.

508,370. COVERING ELECTRIC CONDUCTORS; W. A. Conner, Pittsburgh, Pa. Application filed Dec. 6, 1890. The combination of mechanism for applying a protective covering to wire or cable, with a heated shaft, whereby the wire may be heated prior to the application of the protective covering.



No. 508,188.—Alternate Current Electric Motor.

508,388. ELECTRIC RAILWAY; R. M. Hunter, Philadelphia, Pa. Application filed April 21, 1893. In an electric railway, the combination of outgoing and return conductors to supply current to the motors on the cars, a constant potential and varying dynamo or generating machine for supplying current to the conductors, two or more electrically propelled cars connected with the conductors in parallel, a series wound electric motor arranged on each of the cars and mechanically connected to rotate their axles, independent current collecting devices for each car for supplying current to the motors, and independent regulating devices upon each car for controlling the current delivered to the motors while maintaining them as series motors and in parallel with each other.

508,392. ELECTRIC ARC LAMP; B. Adair & C. H. Klewer, Denver, Colo. Application filed March 6, 1893. The combination with the Brush arc lamp, of a magnet having its coils interposed in the shunt circuit, a short circuit connection through the armature of this magnet when the latter is sufficiently energized, another magnet the coils of which are in the main lamp circuit, and a short connection through the armature of this magnet when not energized.

A CORRECTION.—In the illustrated record of electrical patents published in The Electrical World of Nov. 4, 1893, in the brief description given of patent No. 507,463 for a secondary battery, the address of the patentee, Mr. C. A. Smyth, was given as Momence, Ia., instead of Momence, Ill.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.